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Design Specifications of a Work Station for Five-Platform Scale Truck Inspection Stations

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1/ INTRODUCTION

The Ministry of Transportation and Communications (MTC) operates a number of Truck Inspection Stations (TIS) across the province. These stations are critical to the effective enforcement of Ontario's trucking regulations, designed to protect the highways and highway users of the province. These regulations include such factors as vehicle gross weight, load distributions, vehicle dimensions, and the safety and mechanical fitness of the vehicles.

The new truck inspection station being designed for the Queen Elizabeth Way (QEW) near Oakville will be a modern, highly-efficient station, incorporating state-of-the-art equipment. This station will be used to evaluate new methods and equipment designed to cope with the high truck volumes on this freeway. The methods and ideas developed there will be used to improve operations at truck inspection stations at other locations in the province. For this purpose the station will be equipped with technologically advanced systems, including:

a/ a fully-electronic five-platform scale with the capability to simultaneously weigh up to five individual axle units and provide the total gross vehicle weight;

b/ a weigh-in-motion scale (or presorter) which can measure axle separations and load distributions as trucks enter the station and identify potential weight violators by comparing the truck data with the preprogrammed bridge formula. Potential violators can be automatically directed to the five-platform scale for static weighing;

c/ pavement-embedded loop detectors which interface between the presorter and the various traffic control devices to provide for automatic routing of trucks into the appropriate lanes and to detect certain lane violations;

d/ automatic changeable message signs (CMS) and variable message signs (VMS) to provide for efficient traffic control;

e/ a computer to integrate information, perform logical operations and make the job of the HCI more manageable.

The heart of the operation will, however, continue to be the Highway Carrier Inspector (HCI). The ultimate efficiency of the station will depend on the new equipment but, to a larger extent, it will depend on the interface between the HCI and this equipment, i.e., the design of the man-machine interface. Application of established human engineering guidelines and specifications in the design of the HCI workstation is important in ensuring optimum system performance and operator satisfaction.

The HCI will operate a console providing him with the displays of information required to make decisions and judgements plus the controls to implement those decisions in an efficient manner. This control console must be carefully designed to accommodate a large range of users and also provide good external visibility. While it will have a large number of displays and controls, the console must be easy to understand and operate. This will ensure user acceptability, maximum operational efficiency and minimum requirements for retraining.

This report describes the development of the HCI workstation, from the conceptual development of operational procedures to the specification of the design and layout of the console and environment. The systematic process began with a comprehensive analysis of operator tasks. The final specification and layout of the HCI workstation was reviewed in mock-up form with the Project Review Committee and experienced HCIs.

This report is organized in nine chapters. Chapters 1-4 describe the study approach, methodology, the task analysis, and the information and control requirements of the HCI. Chapters 5-7 provide the detailed specifications necessary to produce the HCI workstation, including specifications for the controls and displays, workstation geometry and layout, and the working environment. Chapter 8 is a brief description of the computer and Chapter 9 is a brief list of some of the recommendations made in this report.

2/ APPROACH

The purpose of this project was to design an HCI workstation which conformed to good human engineering and ergonomic principles, including: console size and configuration, display and control design, integration of controls and displays, optimization of console layout, human reach envelope, etc. In addition, it was considered that the workstation design should incorporate three important features:

- **Modularity**
  The control panel was to comprise separate subpanels each containing functionally-related controls and displays. Modularity should assist HCIs in learning new tasks and it should also permit future expansion or modifications to the console to be made without the need for extensive reconstruction.

- **Conciseness**
  It was considered important to minimize the total number of individual displays and controls on the control console without sacrificing capability. Therefore, multi-functional controls and indicators were used, where practical, in an attempt to reduce the clutter on the console.

- **Simplicity**
  The overall design will use as much computer logic as practical in order to simplify normal operations in the workstation, thereby reducing HCI workload and improving efficiency.

The development of the HCI workstation followed a systematic iterative process which is depicted in Figure 1. The process involved essentially six phases:

- determination of system objectives and functions;
- task analysis;
- control and display specification;
- control console specification and layout;
- specification of the working environment; and
- mock-up review.

Throughout the project, progress review meetings were held to address and clarify problems that may have arisen and to ensure that the conceptual designs met the project requirements.

Background information pertinent to the project was obtained from reports and documents, discussions with various MTC personnel and site visits to currently operating stations. This information became the basis for the framework of operator procedures and tasks. These tasks were then revised and broken down into subtasks which described in detail all operator actions and decisions.

The next step was to analyze these operator tasks in order to determine the operator information and control requirements. These requirements in turn led to specification of control and display characteristics. Link analyses were employed in designing individual subpanels to optimize the positioning of various items within each subpanel and finally in the determination of the overall console layout.

The design of the control console was then examined in relationship to the proposed scale house to ensure that it could be properly integrated within the total scale house environment and to resolve any incompatibilities among the design of the workstation, operator procedures and tasks, and the design of the scale house.

Conceptual designs of the control console and subpanels were refined and a full scale mock-up was constructed to demonstrate the proposed design. Finally, a critical design review meeting was held to ensure that the proposed design met all of the requirements and was acceptable to the user.

2.1/ Scope

The work performed under this project focused on the design of the HCI workstation. Specifications are provided for both the hardware and software control necessary to produce the control console. These specifications are rigid enough to ensure a well human-engineered workstation, yet flexible enough to allow equipment from different manufacturers to be

used in the final construction. The design of the equipment or interfaces outside of the workstation was beyond the scope of this work.

The task analysis was similarly restricted to tasks and subtasks which would be performed at this workstation. It is recognized that the HCI is responsible for other tasks which do not directly involve the workstation, such as the sale of permits and, therefore, these tasks are not reflected in the task analysis.

3/ TASK ANALYSIS

The first major step in the design of a workstation was a comprehensive analysis of operator tasks. A task analysis records and documents the specific procedures used by an operator, and can then be used to determine what information the operator needs to make certain decisions and judgements, and what controls he requires to perform his tasks. The task analysis can also be used to review the logic associated with certain tasks, to help design the necessary software, to identify inconsistencies or potential conflicts of certain procedures, and to determine the operational efficiency of the workstation or the implications of specific workstation modifications. At this stage, of course, the nature of the operation is strictly conceptual as there are currently no other stations in operation which employ a five-platform scale or which are similarly configured. It follows, therefore, that the HCI tasks are, at this stage, conceptual in nature and quite different from the tasks performed at existing stations.

Task analyses have other indirect benefits as well. For example, they are instrumental in ensuring that all personnel involved in a given project have a common understanding of the tasks and interactions underlying the operation. Task analyses also assist in understanding the complete system by providing the overall task structure and inter-relationships among tasks, subtasks and the various system components.

There are different types of task analyses, each suited for a particular application. In the present application, the requirement was for the development of detailed procedures for the workstation operator and for the determination of the operator requirements in terms of information and control. The major elements of the task analysis included:

- the development of consistent HCI tasks and procedures for the proposed station;

- the organization and enumeration of tasks;

- the breakdown of these tasks in terms of their subtasks; and

- the analysis of these subtasks in terms of the information and control requirements of the operator.

Basic information about TIS operations, HCI functions, operating conditions, and constraints was obtained from interviews and discussions with the project manager, project engineers and experienced HCIs. Also readily available was information about the design characteristics of the five-platform scale, the presorter scale and the variable message signs.

3.1/ Operational Sequence Diagrams

The first stage of the task analysis involved the construction of Operational Sequence Diagrams (OSDs). OSDs are functional block diagrams which show the sequence of tasks performed by the HCI in a flow chart format, including interactions with other system elements (in this case the truck). A complete set of OSDs describing HCI tasks is provided in Appendix A. These will be useful for future modifications in the station or HCI procedures.

There are seven discrete HCI tasks, as shown by the overall task structure in Figure 2, namely:

1/ Startup
2/ Position truck
3/ Weight truck
4/ Inspect truck
5/ Monitor traffic
6/ Control traffic
7/ Shutdown

As Figure 2 shows, the HCI must constantly share his attention between Tasks 2, 3 and 4 and Tasks 5 and 6 as these parallel sets of tasks must often be performed concomitantly.

Each task is represented by an OSD and is broken down into component subtasks. The OSD legend is also provided in Appendix A. There are three types of subtasks for each of the tasks:

1/ receipt of information
2/ decisions
3/ actions

Thus, each OSD provides the sequence of subtasks performed by the HCI and, where applicable, the reactions of the truck. These subtasks are displayed from top to bottom in the appropriate column in the proper order of occurrence (but not necessarily to an accurate time scale). HCI subtasks of a given task are identified by lower case letters. Interactions between the HCI and the truck are shown as horizontal lines between the columns. A REMARKS column provides additional comments or clarification of the HCI actions.

4/ HCI INFORMATION AND CONTROL REQUIREMENTS

A human operator can be thought of as a controller; that is, a black box which receives information from the environment, processes it and produces certain control actions to achieve a desired effect. This is often referred to as the "man-in-the-loop model". In order to function effectively, therefore, the man-in-the-loop must receive appropriate information to enable him to decide what he should do and he must have the controls to allow him to do it. In order to function efficiently, this information must be legible and in a form appropriate for use. Similarly, the controls must be compatible with operator expectations and capabilities.

The operator task sequences described in the previous section were reviewed to determine what displays and controls must be provided to the HCI to permit him to perform his tasks effectively. The summary listings of information and control requirements for each task performed by the HCI are provided in Chapter 5.

The next step would be to translate the information and control requirements of individual tasks into specifications for controls and displays. However, it was first necessary to decide on one of two general design philosophies.

One approach is to make a schematic layout in which the console is a basic map of the system being controlled with displays and controls in the same relative position as they are in the "real world". This method is easily learned and understood because the relationship between the console and the "real world" is readily apparent. The danger of this approach is that it may involve long reaches, as controls that are used frequently may not be centrally located. The same problem occurs when displays in which information must be related or used with other displays or controls force the user to employ excessive eye and head movements to perform normal operations.

The second method is to group displays and controls according to their function and not by their spatial relationship in the "real world". This

means that controls that are used together will be close together to minimize hand and eye movements, reduce fatigue, and increase the speed of operation. However, with this type of layout it is more difficult to see the relationship between the external world and the console.

Both of these approaches were considered in designing the HCI's console. When a completely schematic approach was tried it required excessive hand and arm movement on the part of the HCI, especially for traffic control tasks. After experimentation with different layouts, a hybrid design was chosen which has schematic layouts within independent functional groups. Thus, the traffic control group contains all displays and controls needed for traffic control. Within that group they should be arranged in a schematic layout which represents the actual layout of the signs, etc. in the inspection lanes.

In order to develop a functional console design, the workstation was conceptualized as having eight distinct functional modules which may or may not correspond to physical groupings on the console. These modules are briefly described below.

Module 1/ Truck Positioning
This functional module contains all of the displays and controls to enable the HCI to correctly position and control the trucks in lane #1.

Module 2/ Traffic Monitoring and Control
This module contains all of the indicators and controls which are required to monitor and direct traffic through the station. The relationship between the controls and displays will closely resemble the actual station layout to facilitate operator orientation.

Module 3/ Five-Platform Scale Information and Control
This module contains the gross weight display and the individual scale platform displays, including all associated controls and indicators.

Module 4/ Presorter Scale Information and Control
This module provides the presorter data for violators in a format designed to assist the HCI in determining violation type, etc. This module

should also provide information, indicating the proper positioning of the steering axle on the scale, in order to assist the HCI in positioning the truck.

Module 5/ Truck Visual Inspection

Although, strictly speaking, this is not a modular component of the workstation, the requirements related to the visibility of objects outside of the scale house affect the size and configuration of the control console and its location within the scale house. It may also affect the architectural design of the scale house itself.

Module 6/ Audio Communications

This module includes the public address system and all associated equipment.

Module 7/ Power Control

This module may be divided into two parts. One part is a front-mounted subpanel which includes all of the main system power controls and tests. The second part may be hidden, or locked, and contains individual power controls for all of the systems powered by the control console.

Module 8/ Miscellaneous

This rather vaguely-defined module includes all individual controls or displays which are required by the operator but which do not conveniently fall into any one particular module. An example of this is the printer which is secondary to the actual weighing operation and, therefore, not required in the primary display or control area.

5/ REQUIREMENTS OF EACH MODULE

This chapter describes the control and display requirements for each of the workstation functional modules. These requirements would eventually lead to the formulation of the detailed specifications for the controls and displays which must be incorporated in the control console. The requirements for each functional module can originate from any of the seven main tasks described in Chapter 3. Therefore, before compiling a complete set of control and information requirements for each module, it was necessary to construct a table showing all of the subtasks which are related to each of the modules. This module and task reference matrix is presented in Table 1.

The table provides a convenient reference to all of the tasks and subtasks identified in the OSDs that are associated with any given module. Hence, proposed changes to the desion of the workstation can be easily examined in terms of their impact on the tasks performed by the HCI. Conversely, any contemplated change in operator tasks can be evaluated by considering whether existing console designs can accommodate the proposed changes in the procedures or what modifications would be required to accommodate the proposed change.

This matrix assisted in preparing the information and control specifications for each of the workstation modules which appear in the following tables.

The expanded module descriptions that follow have two major headings:

- Information, describing the information that must be given to the HCI,
- Control, describing all the controls needed by the HCI in that module.

Table 1/ Workstation Modules and Task Reference Matrix

MODULE	TASK	SUBTASK REFERENCE
1	1	b,g
	2	a,c,j,l
	3	d,g,k,l,p,s,u,w
	5	c,i
	6	j
2	1	b,e,g,h
	4	c,d
	5	a,b,e,f,g,i
	6	e,i,k,p,q,r
	7	a,b
3	1	b
	3	d,g,j,o,r,v,x
	7	c
4	1	b,d,f
	2	e
	3	a,q
	5	a
5	2	b,d,e,f,g,h,k,l
	3	b,c,h,i,l,m,n,q,v
	4	a,g
	5	a,d,h
	6	a,b,c,d,h,p,r
6	1	b
	2	i
	3	a
	4	b
	5	a,d,e
	6	g,o
7	1	a,b
	7	a,b

5.1/ Module 1 -- Truck Positioning Requirements

Information

- Feedback of VMS status
- Position of truck

Control

Instruct driver to:
a/ enter
b/ stop
c/ move forward
d/ park
e/ leave
f/ back up

Plus a WAIT control to override automatic operations.

All of the above controls should be alternate action controls; be illuminated when depressed; and be mutually excluding as only one VMS message can be displayed at a time.

5.2/ Module 2 -- Traffic Monitor and Control Requirements

Information

Status of all traffic control devices including:
1/ GO/STOP lights in lane #3
2/ GO/STOP lights in lane #2
3/ First CMS prior to Presorter, (indicator)
4/ Second CMS after Presorter, (indicator)
5/ Station ENTER sign

Alarms to include indicators for:

1/ Truck entering lane #1 or #2 by mistake, including:
   - lane truck was directed to,
   - lane truck actually is in.
2/ Lane #1 capacity exceeded
3/ Lane #2 capacity exceeded
4/ Over-height

Control

1/ GO/STOP light control for lane #3
2/ GO/STOP light control for lane #2
3/ First CMS select control
4/ Second CMS mode and lane controls
5/ ON/OFF control for station ENTER sign

5.3/ Module 3 -- Five-Platform Scale Requirements

Information

1/ Individual scale platform weights
2/ Cummulative and total gross weight
3/ Scale power
4/ Indication of which scales have been selected

After the truck passes over the exit loop detector, scale displays, registers, and accumulator are automatically reset.

Control

1/ Scale SELECT control -- Will not print weight, show weight on VMS, or enter accumulator if platform is not selected.

2/ Scale ZERO control -- One single control automatically zeros all platforms.

3/ A control to allow the five-platform scale to be used as single-platform scale.

4/ A MANUAL OPERATION control to be used if a truck cannot fit on the scale (an alternate action control illuminated when depressed).

5/ A PRINT control to print the weights.

Notes on the Print Function:

Automatic Mode

* Prints all individual platform weights greater than 250 kg.
* Prints gross weight (sum of the above).
* Automatically overrides scale motion detector.
* When a vehicle passes over the exit loop, the system reset registers.

Manual Mode

* Prints all individual platform weights greater than 250 kg for platforms which have selected by the HCI status.
* Prints accumulated total gross weight (sum of the above).
* When printing is complete, de-selects the selected platforms.
* Automatically overrides scale motion detector.
* when a vehicle passes over the exit loop, the system resets to automatic which clears all registers as it would in the automatic mode.

5.4/ Module 4 -- Presorter Scale Monitor Requirements

Information

1/ Presorter scale power status
2/ Presorter scale condition
3/ Lane truck is directed to

For trucks directed to lane #1:

4/ Vehicle classification (number of axles)
5/ Axle spacings

6/ Violation type (speeding, tailing, axle weights and gross weight)
7/ Excess weight (on which axle or gross excess weight)
8/ Where to position steering axle

Control

- ADVANCE forces the CRT to advance the display by one vehicle.

- HOLD stops the CRT from advancing when the exit loop is tripped.

Note: Presorter automatically inserts message when a vehicle exits from the park area (this implies addition of a loop detector at the re-entry point).

5.5/ Module 5 -- External Visibility Requirements

Information

The HCI should be able to see:

Primary
- Truck in lane #1 for visual inspection
  - all truck axles and axle units
  - all truck suspension units
  - all scale platforms

Desirable
- Clearance behind truck being positioned
- Trucks in lane #2 for visual inspection
- Trucks in lane #3 for visual inspection
- Traffic flow
- Truck queue lengths
- Location of other HCIs
- Trucks in all three lanes near over-height detector

5.6/ Module 6 -- Communications Requirements

Information

- Audio alarms for
  1/ truck avoiding scale
  2/ lane full
  3/ overheight
  4/ violations at the presorter
- Information from other HCIs

Control

- Boom microphone and P.A. press-to-talk control to:
  - advise or instruct driver of truck or
  - communicate with outside HCIs
- Alarm reset

5.7/ Module 7 -- Power Control Requirements

Information

- Power status of all subsystems

Control

- Overall Power control
- Automatically resets system to start mode
- Individual controls for:
  - five-platform scales
  - presorter scale
  - computer
  - printer

- both CMSs
- VMS
- all traffic control lights

Main console power control is to have a key to restrict the use of specialized equipment.

6/ CONTROL CONSOLE DESIGN

6.1/ Approach Used

The last chapter has defined the information and control requirements to perform the tasks described in the OSDs. The final step is to translate this into an actual layout of keys, switches and controls on a physical console.

The following are some of the important factors that were taken into consideration during the design process:

- most used controls/displays located centrally
- related controls/displays grouped together
- short hand travel for controls used in sequence
- short eye travel for displays used in sequence
- standardization of shape and colour where practical
- all controls to be within a normal reach envelope
- accomodation made for individuals of different sizes, including males, females and, where possible, handicapped
- maintenance of good external visibility
- consideration of left-handed users
- where practical, maintenance of the spatial relationship to the overall station layout.

While this list is by no means comprehensive, it does give some idea of the number of interplaying factors which resulted in many iterations of the design.

6.2/ Maintenance of External Visibility

The HCI who is seated at the console must be able to see the truck that is on the weigh scale, both for visual inspection and for positioning. This means that he must see either over or around the console. When attempts were made to employ a console that the HCI could see around, it was found that excessive head movements were needed and it was concluded that the HCI would have to see over the console used. This means that the console height will be determined by the eye height of the smallest

user who will have the hardest time seeing the scale and positioning the truck.

After determining the size of the console panel needed to accommodate the required displays and controls, commercial consoles were examined. Unfortunately none could be found which met the visibility and reach requirements. Figure 3 is an example showing an "off-the-shelf" console placed in the weigh station. As Figure 3 shows, it is not possible for an average person to see the scale when seated. Therefore, a custom cabinet is recommended. The recommended console will be described in sufficient detail that it can be made accurately, but with enough flexibility to allow competing manufacturers to produce their own version.

6.2.1/ Developing Console Overall Dimensions

The critical design factors are:
a/ to provide sufficient space for the displays and controls,
b/ to permit the short user to see over the console, and
c/ to provide sufficient leg room for the tall user.

The first step then is to determine who the shortest and tallest users are. The tallest operator normally used in designs of this type is the 95th percentile male (i.e., only 5% of the male population is taller). The shortest operator is the 5th percentile male (i.e., 5% of males are shorter) or the 50th percentile female (i.e., 50% of females are taller)

NOTE: This was just a starting point as adjustments were later made to accommodate shorter individuals and those in wheelchairs as well as handicapped (crutches).

In order to provide optimal external visibility the HCI should be as close to the window as practical. Thus, we will start with a 254 mm (10 inch) wide flat working surface which is the minimum recommended. If we now assume that a 203 x 254 mm (8x10 inch) display will be used for the pre-sorter and it has a 25.4 mm (1 inch) bezel around it, we have a 254 mm (10 inch) high display subpanel that must sit at the back of the

working surface. In order to determine what angle to put the display, we assume that a short (5th percentile) male or average female is seated at the console -- this would place the eyes 404 mm (15.9 inches) over the work surface.

Note --The eye heights used all assume a normal slouch, and are thus on the conservative side. A person of even shorter stature than the person designed for can still see by raising the head or sitting upright.

If we now assume that the most critical information (the data on the truck being weighed) is at the top of this display, we should have this at right angles to the visual path. Thus, the angle of the display is 125° and the top profile of the console has been determined, as shown in Figure 4.

Now, just as the small individual determined the height above the work surface, it is the large individual (95th percentile male) who determines the leg room needed under the work surface. This means that the work surface should be 762 mm (30 inches) from the floor. If we allow about 355 mm (14 inches) for depth of the presorter display, then the depth from the front of the work surface to the back of the console is 762 mm (30 inches). This has now determined the approximate outline of the console if viewed from the side.

The next step is to examine the visibility of a console with these basic dimensions. Figure 5 is the profile, as defined so far, as it would sit in the station. Table 2 gives the dimensions for the figure. It can be clearly seen that good visibility would be provided by a console having this profile as the viewing height "V" less than the maximum criterion of 404 mm (15.9 inches).

Table 2/ Dimensions for Figure 5

A	2.44 m (8 feet) scale to station
B	305 mm (1 foot) above grade.
C	762 mm (30 inches) deep
D	762 mm (30 inches) high
L	line-of-sight
V	396 mm (15 6 inches) viewing height

If we now add the additional dimensions to accommodate legs and feet, including those in wheelchairs, we can obtain the console cross-section in Figure 6. Table 3 gives the dimensions.

Table 3/ Dimensions for Figure 6

B	254 mm (10 inches)
C	about 254 mm (10 inches)
D	762 mm (30 inches)
E	at least 406 mm (16 inches)
F	at least 610 mm (24 inches)
G	at least 165 mm (6.5 inches) (for wheelchairs)
H	about 51 mm (2 inches)
I	about 762 mm (30 inches)
S	125°

Based on the reach envelope of the North American population, the console width should be less than 1016 mm (40 inches) or, more correctly, controls must be no further than 508 mm (20 inches) from the centre of the console. The recommended chair height for a console of this nature is 381 to 457 mm (15-18 inches), adjustable. If, however, it is made 381 to 495 mm (15-19 5 inches) adjustable, then it will allow a wider range of females and handicapped individuals to be accommodated. Table 4, based on "Humanscale 1/2/3" from MIT Press, gives the percentiles of the shortest and tallest users for several population groups accommodated by the console.

Table 4/ Shortest and Tallest Users

	SHORTEST	TALLEST
normal:		
male	5th percentile	95th
female	5th percentile	95th
handicapped:		
male	5th percentile	95th
female	50th percentile	95th
wheelchair:	average adult	

In order to optimize external visibility, it is recommended that the console be located at the left of the work area, facing the scale and as close to the front window as possible. The position of an average adult seated at the console and leaning back in the chair was calculated. A line was then drawn from this observer, "O", past the edge of the window to the right. This is shown as the arrow in Figure 7. It can be seen that there is excellent visibility to the right from this console if it is placed at the left side of the work station.

Therefore, a console with these outside dimensions will meet the requirements of good external visibility.

6.2.2/ General Console Layout

The final design and layout had to meet the information and control requirements of Chapter 5 plus the human factors requirements of Section 6.1. After several iterations, the final design has five subpanels on the console and a keypad and microphone on the work surface.

Note:-- These physical subpanels are related to, but not exactly the same as the functional modules of Chapter 5. The general layout is shown in Figures 8 and 9.

6.3/ Presorter

The presorter display, subpanel 2, Figure 8, is a CRT which should have the following characteristics:

- character height 3 to 5 mm
- dot matrix 7x9 (minimum)
- width-to-height 3:4 (character)
- contrast ratios
  - character/background 8:1 or more
  - background/surround 10:1 or less
- inter-character spacing 0.2 to 0.5 character height
- inter-row spacing 1 to 1.5 character height
- inverse video/flash
- invisible cursor
- luminance between 80 to 160 cd/m^2

In addition, the following points will aid the display of information.

1/ Information about vehicle weights should be right-justified to minimize eye movement.

2/ Messages for which there are not weigh-in-motion scale weights, but just a message, should be left-justified.

3/ There should be at least one blank line between each entry.

4/ Each entry should be added beneath the currently displayed entries.

5/ When a vehicle trips the static scale exit loop, the entry at the top of the display should be erased as the second from the top is moved to the top, unless the HOLD key is active (see Section 6.4).

6/ The ADVANCE key (see Section 6.4) should advance the display one entry in the same manner as a vehicle tripping the static scale exit loop.

7/ With the HOLD key (Section 6.4) active, new data should be added to the screen if there is room on the display. If there is not room, then the data should be stored until needed.

8/ The maximum number that need be handled at once can be found by dividing the distance between the presorter and the static scale by the length of the shortest trucks.

9/ Warnings (such as overweight axles) should be shown in inverse video.

10/ If something trips one of the presorter alarms (e.g., a truck missed the weigh-in-motion scale), it should be shown in inverse video and flashing.

11/ The screen should have a non-reflective treatment (e.g., etched glass).

A sample presorter display is shown in Figure 10.

6.4/ Truck Positioning

Truck positioning and weighing will be the activity requiring the most hand use. For that reason it should be done using a well-designed keypad. Figure 11 shows the recommended keypad. It has been carefully designed using link analysis to minimize hand movements and errors. Although the keypad contains 12 keys, normal operation will require only the central 4 keys (STOP, LEAVE, PRINT, and PARK).

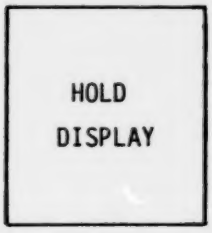
6.4.1/ Key 1

←--- White

Action:

- Causes the presorter display to advance one vehicle.

6.4.2/ Key 2

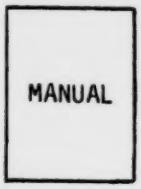


←--- White (Orange when display held)

Action:

- Causes the presorter display to stop automatically advancing when a vehicle trips the exit loop. Data on incoming vehicles continue to be collected.

6.4.3/ Key 3



←--- White (Orange when in manual)

Action:

- When depressed it causes the weighing function to go from automatic weighing to manual weighing. This means that platforms have to be manually selected and are de-selected when the PRINT key is hit. When a vehicle trips the exit loop, the total is cleared and operation reverts to automatic platform selection.

6.4.4/ Key 4

←--- White (Orange flashing when active)

Action:

- When any alarm is tripped this key should flash <u>orange</u> until depressed, which will reset the alarm.

6.4.5/ Key 5

Action:

- This key is only active if the STOP is held down at the same time (this can be done with one hand). As long as both are held down, the VMS will show "BACKUP", the key will light, and the VMS display subpanel (see Figure 15) will have a yellow LED on beside "BACKUP". When released, the VMS returns to "STOP".

6.4.6/ Key 6

Action:

- This is a momentary action key that will cause VMS to show "FORWARD" as long as it is held down. While held down, it should light up and the VMS display subpanel (see Figure 15) will have a yellow LED on beside "FORWARD".

6.4.7/ Key 7

←--- White (Yellow when active)

Action:

- Normally, this key will just flash on as an indicator to show that the system has detected the departure of a vehicle over the exit loop and has put the "ENTER" sign on to bring the next one onto the static scale. If, however, the WAIT key has been activated, then pressing the ENTER key will cancel the WAIT and return to normal operation.

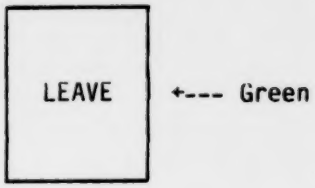
6.4.8/ Key 8

←--- Red

Action:

- When touched, this key will cause the VMS to display "STOP", it will light up, and the VMS display subpanel (see Figure 15) will have a yellow LED on beside "STOP". It will stay this way until FORWARD, BACKUP, LEAVE, or PARK are depressed.

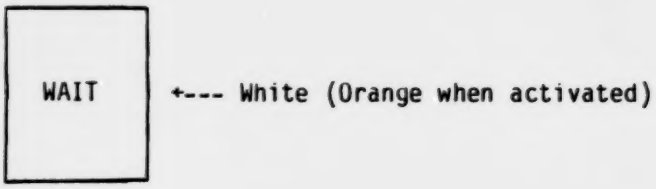
6.4.9/ Key 9



Action:

- When touched, the VMS will display "LEAVE", the key will light up, and the VMS display subpanel (see Figure 15) will have a yellow LED on beside "LEAVE". It will stay on until the vehicle trips the exit loop.

6.4.10/ Key 10



Action:

- When depressed, this key lights up orange and prevents the automatic display of "ENTER" when the exit loop is crossed until the ENTER key is depressed.

6.4.11/ Key 11

Action:

- Will cause accumulated gross weight and individual weights to be printed on the printer and to be displayed on the VMS. In manual mode it will de-select all selected platforms. The accumulator and registers will clear when the vehicle trips the exit loop.

6.4.12/ Key 12

Action:

- When this is touched the VMS will display "PARK" until the exit loop is tripped. As long as the VMS is displaying "PARK" it will remain on.

6.5/ Scale Display

This is a 381 x 89 mm (15 by 3.5 inch) subpanel (see #3, Figures 8 and 12) located at the top of the console panel so that the weights can be seen with minimum eye movement after positioning the truck. The light-emitting diode digital displays are connected so that the last digit does not change but is connected to the power of the corresponding platform. It thus indicates whether power is ON or OFF on each platform.

Switches S1 to S5 are momentary Presslite switches of the 800 series or equivalent. All are white with black engraved lettering saying "SELECTED". In normal operation they are not used as switches but as indicators to show which of the platforms exceeds 250 kg and will thus be printed if the PRINT key is hit on the keypad. If the MANUAL key on the keypad has been depressed it means that the truck will require more than one weighing and the unit will sum and print only those platforms that are manually selected. The platforms so selected will have the SELECTED switch illuminated to show which scales will be used. After the PRINT key is used, the scales will all be de-selected and then wait for the next selection of platforms. This should help prevent a platform being accidently included.

Switch S7 is a white pushbutton labelled "SINGLE" which lights up orange when activated. It will cause all selected platforms to be de-selected and will allow only one platform to be manually selected. It will then use that platform as a single platform scale. Everytime the PRINT is pushed, only the platform weight will be printed and then added to the displayed gross weight. It will continue accumulating until LEAVE or PARK are hit when it will print the accumulated total which will clear when the vehicle trips the exit loop. This method of operation will enable the station to continue to run even without all platforms operating correctly.

Switch S6 is a blue Presslite switch labelled "ZERO". It will cause all platforms to be zeroed.

The displays D1 to D6 are all 12.7 mm (1/2 inch) seven-segment LED displays.

In automatic mode, the SELECTED switches will indicate which weights will be printed when the PRINT key is depressed. In manual mode, the HCI must depress each SELECTED switch that corresponds to the platform that he wants printed.

6.6/ Traffic Control

The traffic control subpanel is a 381 mm x 127 mm (15 x 5 inch) subpanel, #4 in Figure 8, located on the lower central portion of the main console panel. It may be a physically separate subpanel or a portion of the main panel delineated by a lighter colour. On the subpanel will be markings to schematically represent the lanes, the scale, and the location of the over-height beam. There are 7 switches and 4 indicators which are each described in detail on the following pages.

All the switches used for the traffic control subpanel are Presslite, manufactured by Illuminated Products or the equivalent. All seven switches are type 800, momentary contact, dual-lamp, with style-8 switches which have engraved tops with a clear covering to protect them from abrasion. Table 5 shows the colours chosen.

Table 5/ Presslite Switch Colours

Switch	Colours	Colour Codes
S1	white	3285
S2	white/orange	338516
S3	white/orange	338516
S4	green/red	33856
S5	green/red	33856
S6	white/red	33856
S7	white/red	33856

The indicators I1, I2 and I3 are small, red LEDs mounted on a subpanel. I4 is a small engraved subpanel containing yellow LEDs.

The overall layout is shown in Figure 13. Figure 14 shows the parts of the subpanel which are engraved.

6.6.1/ Description of Traffic Control Switches

For clarity, each of the traffic control switches on the control panel is described below in some detail. In the descriptions that follow, the convention is adopted that external signs are shown in square brackets while switches on the panel are shown in angular brackets. For example, the station enter sign is shown as [ENTER] and the switch for the station enter sign is shown as <ENTER>. Exhibit A demonstrates the format used to describe each switch.

Exhibit A/ Format of Switch Descriptions

Switch #__/

←--- Colour (Colour when lighted, if different)

Controls: -- The sign or light that the switch controls.

Indication: -- <ON> What is indicated by the switch being illuminated.

<OFF> What is indicated by the switch being off.

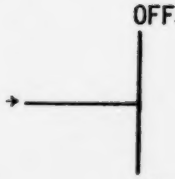
Because of the automatic operations there may also be a difference between what a switch indicates and what it actually controls -- this is why there are separate descriptions. For example, there may be other conditions such as flashing which provide additional information.

Default Condition at Startup: -- The default conditions that prevail when the system is first started will be described here.

Operation

Finally, the logical operation of the switch will be shown with a logic tree, with the → symbol indicating the start.

CONDITION (of switch)	ACTION
OFF	here is what happens when you push the switch when it's OFF.
ON	here is what happens when you push the switch when it's ON.



The following descriptions will define the 7 switches of the traffic control panel.

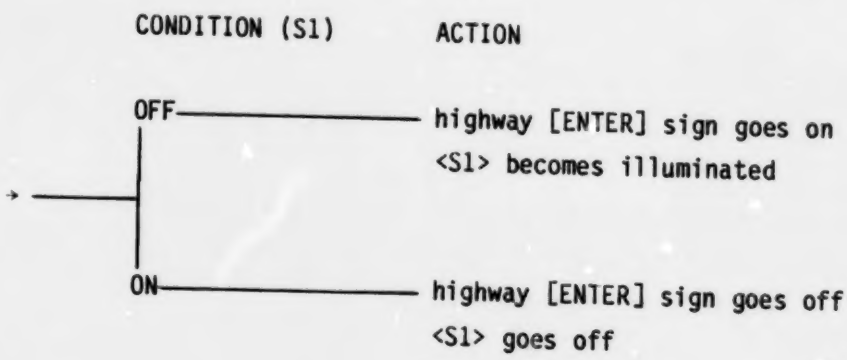
Switch # 1/

Controls. -- The station [ENTER] sign located on the highway.

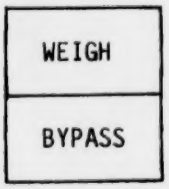
Indication: -- <ENTER> Sign on
<OFF> Sign off

Default Condition at Startup: -- Off

Operation



Switch #2/



<---- White

<---- Orange

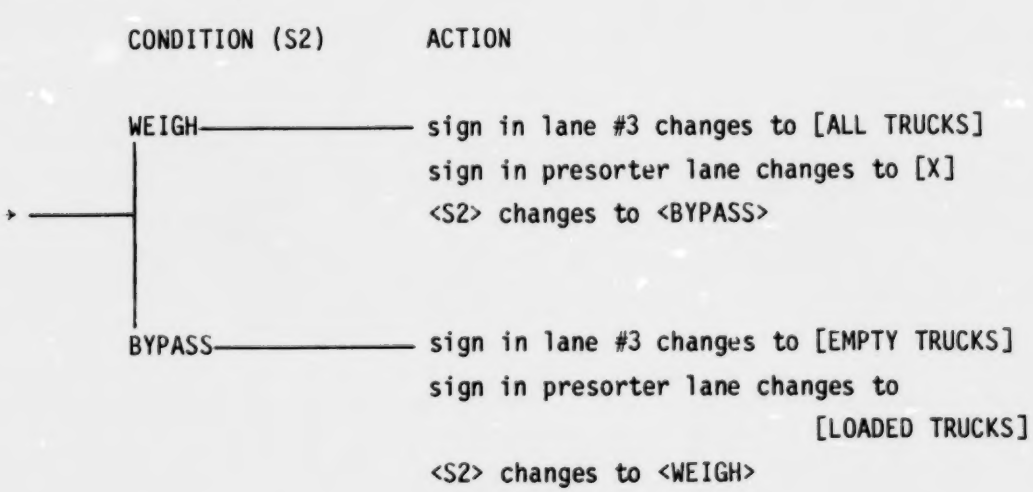
Controls: -- Both of the first CMS signs

Indication: -- <WEIGH> CMS sign in lane #3 reads [EMPTY TRUCKS]
CMS sign in presorter lane reads [LOADED TRUCKS]

<BYPASS> CMS sign in lane #3 reads [ALL TRUCKS]
CMS sign in presorter lane reads [X]

Default Condition at Startup: -- Weigh

Operation



Switch #3/

PRESORT	←--- White
MANUAL	←--- Orange

Controls: -- Whether the second set of CMS are controlled by the presorter or manually by the HCI

Indication: -- <PRESORT> the CMS controlling static scale entry is under presorter control.

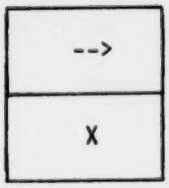
<MANUAL> the CMS controlling static scale entry is under manual control.

Default Condition at Startup: -- Presort

Operation

CONDITION (S3)	ACTION
PRESORT	presorter stops selecting trucks to weigh CMSs in lanes #2 and #1 go to [X] switches 4 and 5 go to <X> <S3> changes to <MANUAL>
MANUAL	presorter starts selecting trucks to weigh CMSs in lanes #2 and #1 go to [X] <S3> changes to <PRESORT>

Switch #4/



<--- Green

<--- Red

Controls: -- The CMS in lane #2

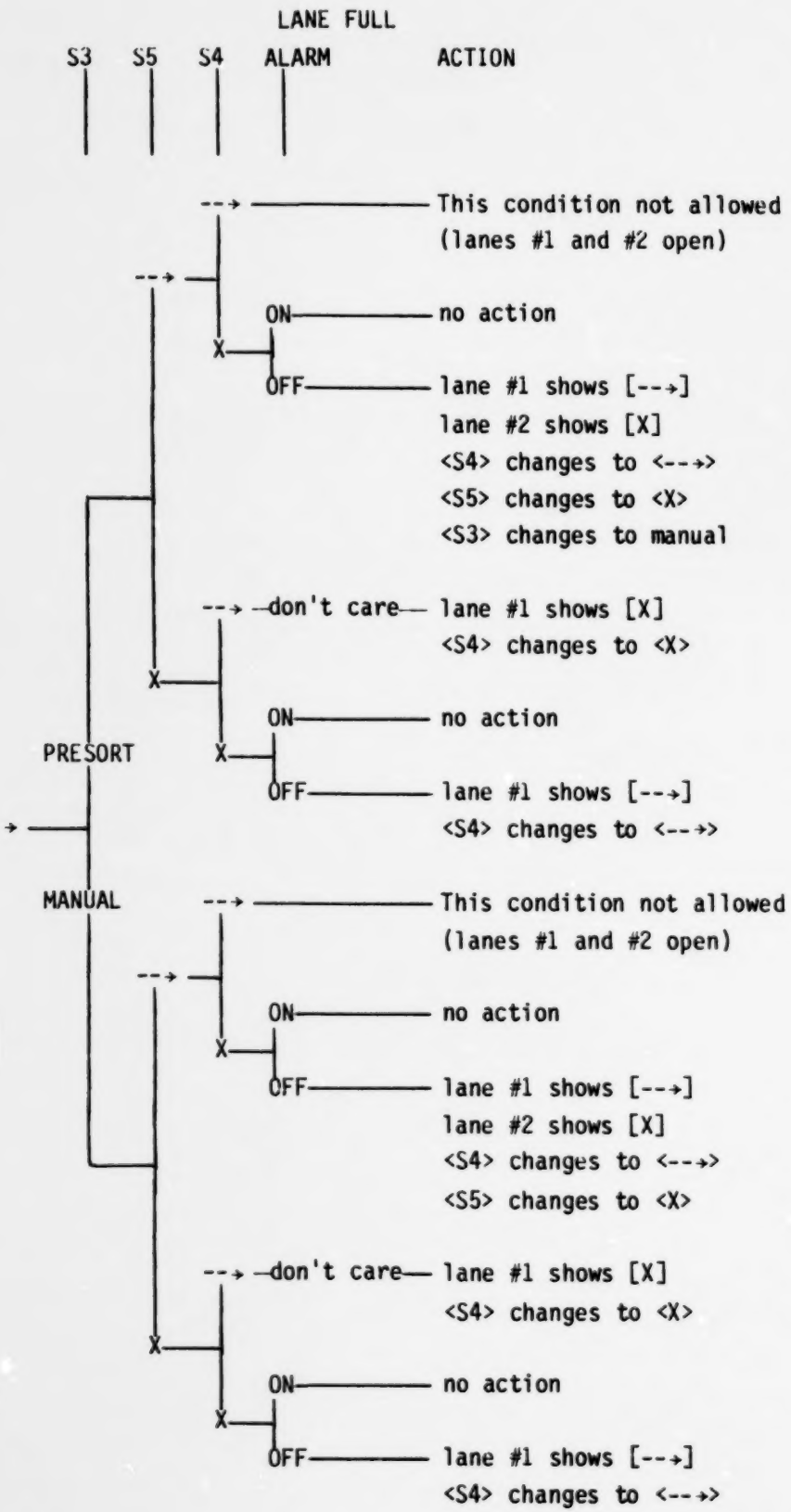
Indication: <-- -> the CMS is displaying a green [-- ->]

<X> the CMS sign is displaying a red [X]

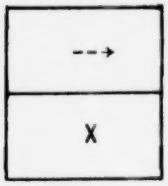
<X> < > <X> a flashing X indicatates that a truck has disobeyed and gone through the red [X] -- an alarm will sound and the exit sign for lane #2 will turn red (see Section 6.10/ Alarm)

Default Condition at Startup: -- X

Operation. -- (See next page.)


LANE FULL
S3
S5
S4
ALARM
ACTION
PRESORT
MANUAL
--→
This condition not allowed
(lanes #1 and #2 open)
ON
no action
X
OFF
lane #1 shows [--→]
lane #2 shows [X]
<S4> changes to <--→>
<S5> changes to <X>
<S3> changes to manual
don't care
lane #1 shows [X]
<S4> changes to <X>

Switch #5/



←-- Green

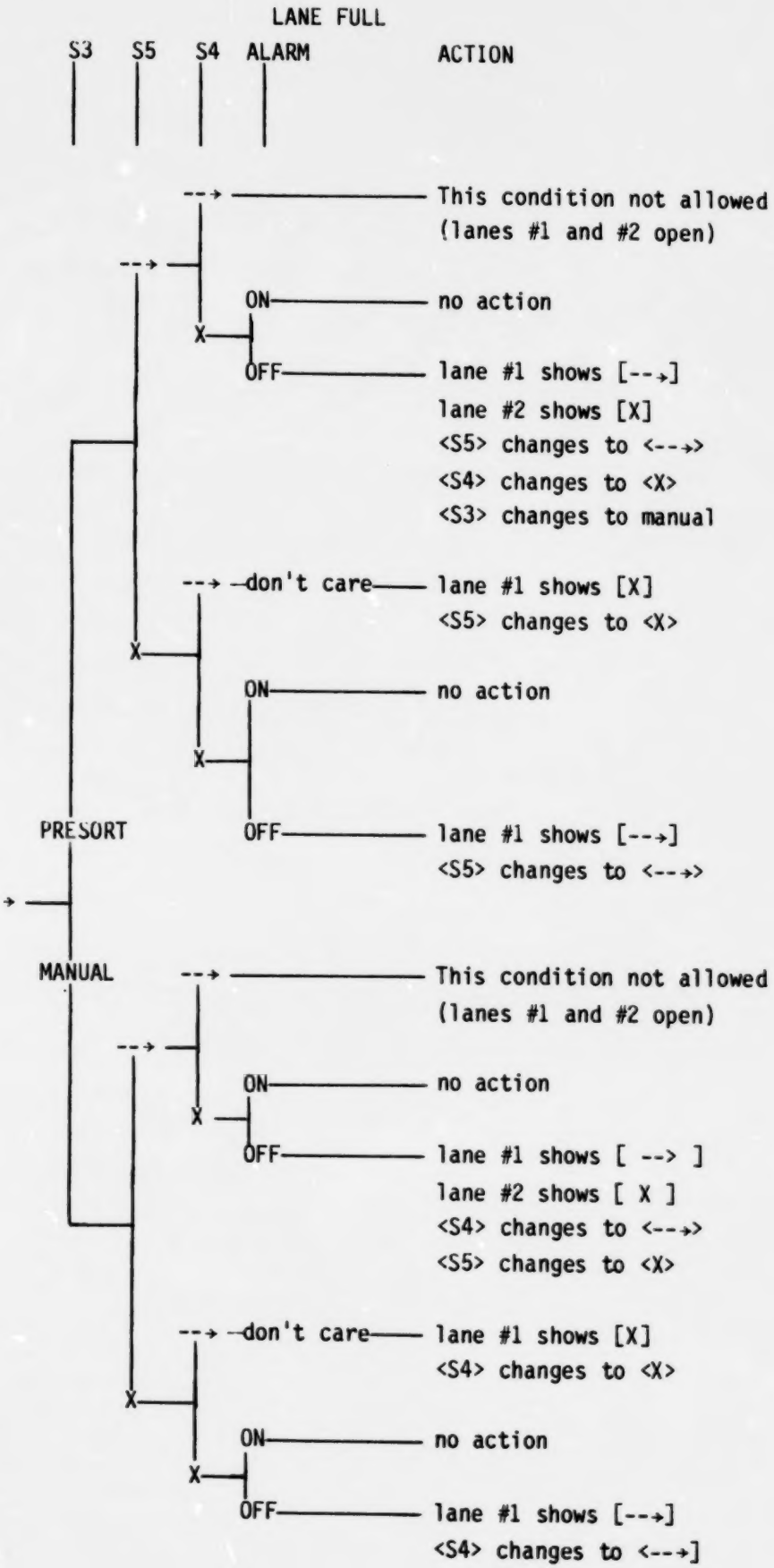
←-- Red

Controls: -- The CMS in lane #1.

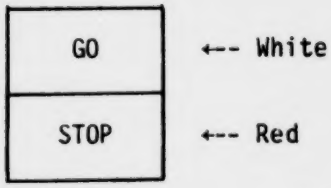
Indication. -- <--→ the CMS is displaying a green arrow
<X> the CMS sign is displaying a red X

Default Condition at Startup: -- X

Operation: -- (See next page.)


LANE FULL
S3
S5
S4
ALARM
ACTION
--→
This condition not allowed
(lanes #1 and #2 open)
--→
ON
no action
X
OFF
lane #1 shows [--→]
lane #2 shows [X]
<S5> changes to <--→>
<S4> changes to <X>
<S3> changes to manual
--→
don't care
lane #1 shows [X]
<S5> changes to <X>
X
ON
no action
X
OFF
lane #1 shows [--→]
<S5> changes to <--→>
PRESORT
→
MANUAL
--→
This condition not allowed
(lanes #1 and #2 open)
--→
ON
no action
X
OFF
lane #1 shows [-->]
lane #2 shows [X]
<S4> changes to <--→>
<S5> changes to <X>
--→
don't care
lane #1 shows [X]
<S4> changes to <X>
X
ON
no action
X
OFF
lane #1 shows [--→]
<S4> changes to <--→]

Switch #6/

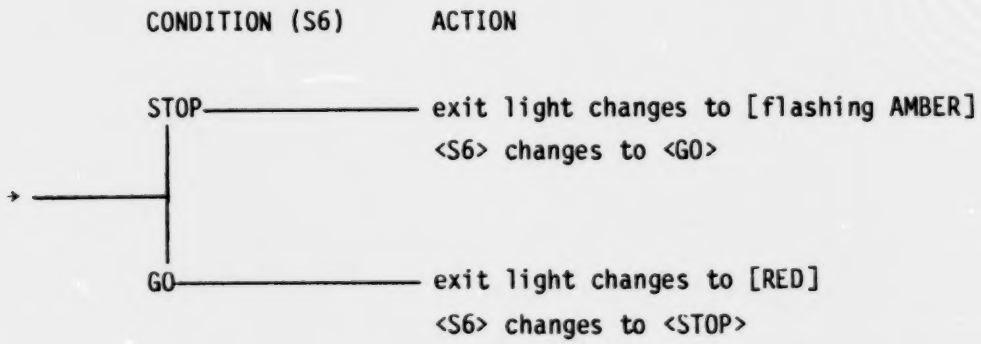


Controls: -- The exit traffic lights in lane #3.

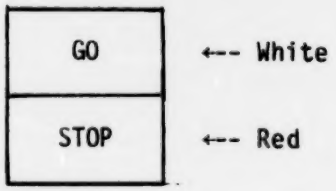
Indication. -- <GO> the exit light is flashing amber
<STOP> the exit light is red

Default Condition at Startup: -- Go

Operation



Switch #7/

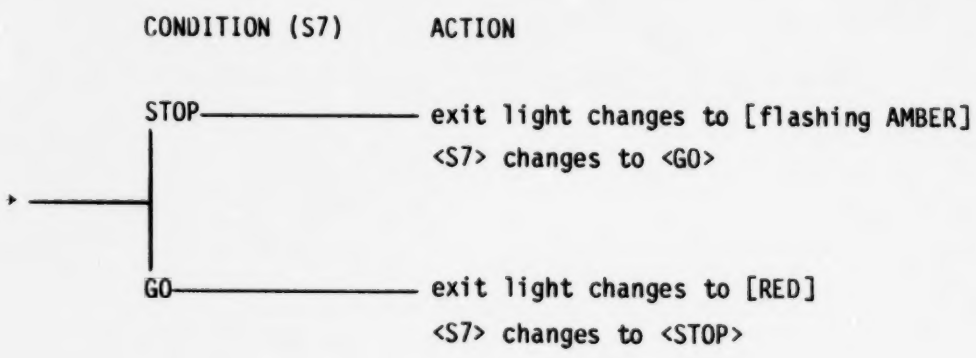


Controls: -- The exit traffic lights in lane #2.

Indication: -- <GO> the exit light is flashing amber
<STOP> the exit light is red

Default Condition at Startup: -- <GO>

Operation



Indicator I1: -- A red LED mounted in the subpanel which indicates when lane #2 is full.

Indicator I2: -- A red LED mounted in the subpanel which indicates when lane #1 is full.

Indicator I3: -- A red LED mounted in the subpanel which indicates when the over-height beam is broken.

Indicator I4: -- A small engraved panel with yellow LEDs beside each of the VMS messages plus WAIT (see Figure 15).

6.7/ Communications

The communications module of the task analysis phase requires two functions. First, an auditory tone to alert the HCI of an alarm condition, and second, a P.A. system to allow the HCI to give oral instructions to drivers and communicate with other HCIs outside the scale house.

The auditory warning requirement can be met by using a solid state audio indicator such as a Projects Unlimited AI-220 or equivalent, mounted inside the console, or on the underside of the 254 mm (10 inch) wide horizontal working surface.

The P.A. interaction will be through a microphone similar to an Electrovoice 634BSRL or equivalent which contains a "press-to-talk" switch. So as not to obstruct vision, this will be mounted on a 152 mm (6 inch) gooseneck and secured to the flat working surface to the immediate right of the presorter display and about 25 mm (1 inch) from the joint to the vertical portion of the console as shown in Figure 9.

6.8/ Power

The power control should consist of two sections, one a subpanel about 51 x 229 mm (2 x 9 inches) on the console left front edge (#1 in Figure 8) with the primary power controls. The other hidden one will contain individual controls for each item of equipment. It should be enclosed by a locked door and will have toggle switches for each piece of equipment that is used in the weighing process. Each toggle switch should have a label clearly showing what it controls. Each toggle switch should be a 3-position type where UP means that the equipment will only come on with the key and DOWN means that the equipment will operate without the key. This can be seen in Table 6

Table 6/ Toggle Switch Functions

- UP < equipment operates only with the key in
- CENTRE < equipment is off
- DOWN < equipment operates without the key in.

NOTE: The same key should be used for both the key switch and access to the toggle switches.

S3 is a switch which will turn on the external night lighting. S4 is a blue latching pushbutton which will cause the panel and signs to go into a test mode. All panel lights will light up, the CMS signs will alternate messages, and the VMS will cycle through all messages and the alarm will sound.

6.9/ Printer etc.

Provision for the printer is made to the right of the console in an 203 x 229 m (8 inches wide by 9 inches high) subpanel (#5 in Figure 8.) This subpanel is located to the right to make it easy to tear off the printout as the HCI leaves to inspect the truck in the rear parking lot. It may be increased in width, if needed, without affecting the overall design. The printer is to be mounted inside the console with the printout fed out through a slot. It must be easy to tear off the printout, replace the paper, and replace the ribbon.

The lower edge of this subpanel should be hinged and a handle put along the top edge to allow the entire assembly to be swung out for repair or replenishment. If this is done, there should be a safety interlock which will disable the power if the subpanel is opened. It may be possible to have paper and ribbon storage inside at the rear which would be convenient

The printer itself should be 20 character unit such as an Epson or equivalent.

6.10/ Alarm

The alarm system is designed to give the HCI an audible and visual warning of something that requires attentions. The following conditions will cause an alarm.

- Overheight
  If a vehicle in any lane interrupts the over-height beam the alarm is tripped.

- Lane Full
  If lanes #1 or #2 reach their capacity then the alarm is tripped.

- Wrong Lane
  If a vehicle is directed to lane #1 after the presorter but goes into lane #2, then the alarm is tripped and the exit light on lane #2 changes to solid red. (Note. if the vehicle is directed to lane #2 but comes into #1 to be weighed, there should be no alarm.)

- Presorter
  There are alarm conditions that will be detected by the presorter, including vehicles that missed the weigh-in-motion scale, and excessive speed.

7/ ENVIRONMENT

7.1/ Temperature

7.1.1/ Range

In the summer, air conditioning is of more benefit in reducing humidity than in reducing temperature. As the HCIs will be frequently entering and leaving the station, thermal shock should be kept to a minimum. As outside temperatures climb, the interior should be allowed to rise as well. Table 7 shows the ideal recommended relationship between exterior and interior temperatures.

Table 7/ Recommended Relationship Between Exterior and Interior Temperatures

Temperatures (°C)	
Exterior	Interior
20	10
22	21
24	22
26	23
28	24.5
30	26
32	28

7.1.2/ Uniformity

The temperature of the air at head level and at floor level should not differ by more than 5.5°C.

The temperature of surrounding surfaces should not be more than 2 to 3°C above or below the air temperature.

7.2/ Ventilation

Adequate ventilation is assured if a minimum of 0.85 m^3 of air is introduced for each occupant Of this, two-thirds shall be fresh air and it should not exceed a velocity of 30 m/min.

7.3/ Humidity

The relative humidity should be between 40% and 50%. Approximately 45% should be provided at 21°C. This should decrease with rising temperature.

7.4/ Noise

It is desirable to keep to noise levels down to reduce fatigue and to facilitate communication. The levels should be less than 65 dbA, but with noisy trucks so close this may not be possible.

7.5/ Lighting

The lighting level at the console surface should be between 325 and 540 lux.

7.6/ Sun Screen

It will be necessary to provide a screen behind the operator to prevent sunlight from washing out the displays at certain times of the day in some seasons. This can be about 1.5 m (5 feet) high and should be parallel to the front window and 1.5 m (5 feet) behind the console. It should be about 1.5 m (5 feet) wide.

8/ THE COMPUTER SYSTEM

As the computer will be such an important part of the operation, some mention of its characteristics should be made. The machine will be expected to do the following:

- gather data in "real time" as each truck passes over the presorter;
- monitor traffic by means of the loop detectors,
- update the displays,
- perform calculations to show correct truck positioning on the five-platform scale,
- gather statistics,
- support more than one user,
- support modern communications protocols, notably X.25 and SNA; and
- have expansion capacity for other tasks.

At the very least, the machine should be a mature computer with a wide choice of reliable software, and proven hardware reliability. The computational work will require hardware math to achieve reasonable speed.

The software options should keep in mind that the proposed station is a test station to develop methods and equipment to be used at other stations throughout the province. Thus, it will be necessary to alter the timing and logic as part of the development process which will require modifications to the software. This means that the software should be easy to change. This is a very strong arguement for using a high-level language. Second, when only one copy of the system is made, such as this test station, it will be much easier and faster to produce

software in a high-level language. The slight additional hardware required to run a high-level language would probably be saved in reduced software costs It is usually only when high hardware volumes are involved (i.e., many copies of the system) that the time and expense of using machine language are justified. It is therefore recommended that a high-level language be used.

The exact language is not as important as the structures within it, which should include.

- if-then-else structures
- select case statements
- do while
- parameter passing
- local variables
- modularizing

The machine itself must be expandable to take care of future development, such as the following

- Data gathering of statistics, experimentation with different parameters, etc. for research by Ministry personnel concurrent with normal station operation.

- Use of additional terminals so that permits and licences can be checked with central data facilities.

- Communication with other Ministry computers.

The system will need to be "real time", "multi-tasking" and "multi-terminal" to meet all of the stated needs without excessive development or modification costs. A careful choice should be made to ensure that the system has the power and flexibility that will be needed.

9/ RECOMMENDATIONS

1/ Any flashing amber traffic light should change directly to red and not have a period of solid amber.

2/ The variable message sign (VMS) should:
-be a Feranti-Packard type of display or equivalent
-have 7 lines for information,
-have the top line yellow and the others white,
-be located sufficiently downline from the scale to allow the longest vehicle to have the rear axles on scale #1 and yet still permit the driver to read the VMS.

3/ A custom console should be made as outlined in Chapter 6.

4/ Software should be written in a high-level language and not in assembler.

5/ Reserve capacity should be available in the computer.

6/ A loop detector should be installed at the re-entry point.

7/ All timing and control parameters should be easily changed.

8/ The over-height detector should be located sufficiently upstream to allow enough time to stop trucks in lane #3.

9/ The computer should use presorter information to determine positioning of the truck and show this on the presorter display console.

10/ Scale #1 should have markings to correspond to correct position. The correct front axle position should be indicated on the presorter display. The exact nature and spacing of the markings will be of the parameters that will be investigated when the station is operational.

11/ Provision should be made to allow use of any one of the platforms as a single-platform scale to allow operation in spite of the failure of a scale.

12/ The window at the front should be less than 990 m (39 inches) above ground.

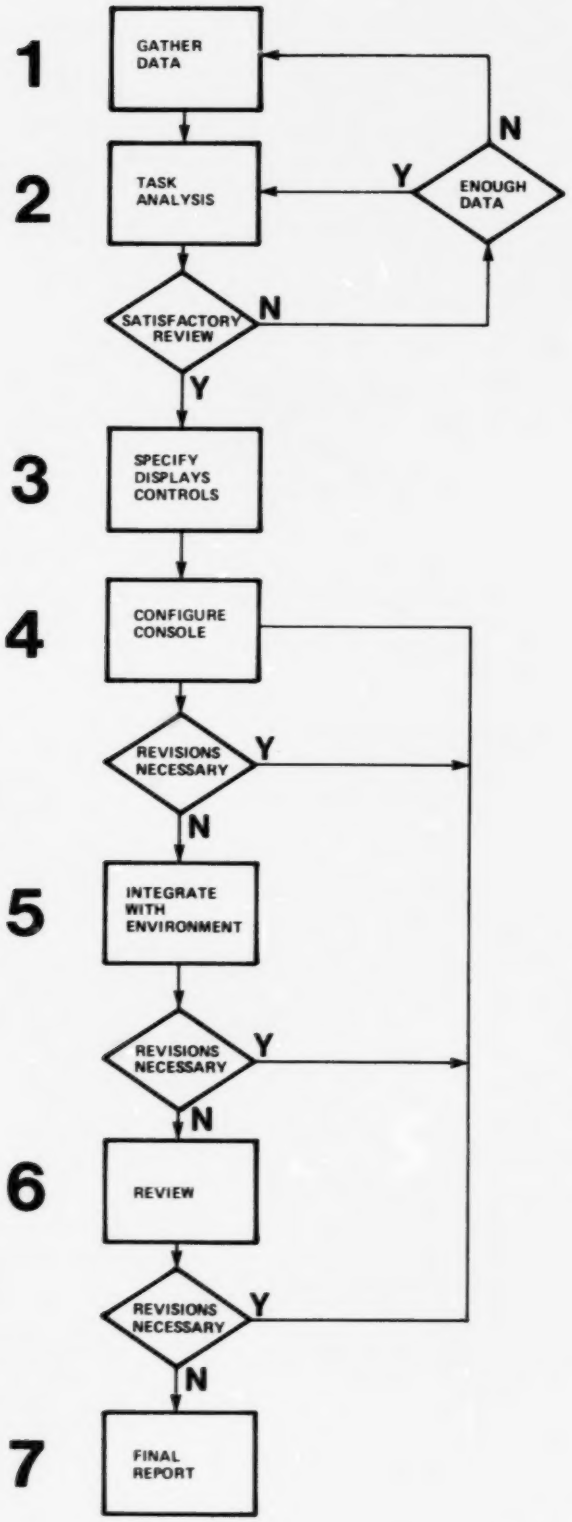


Figure 1/ The Design Process

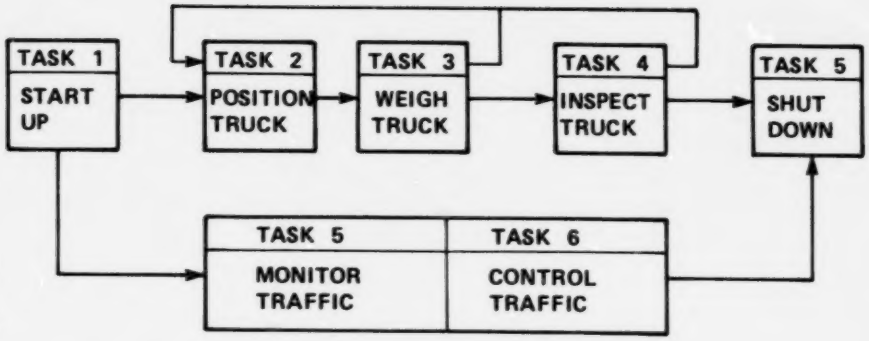


Figure 2/ The 7 HCI Tasks

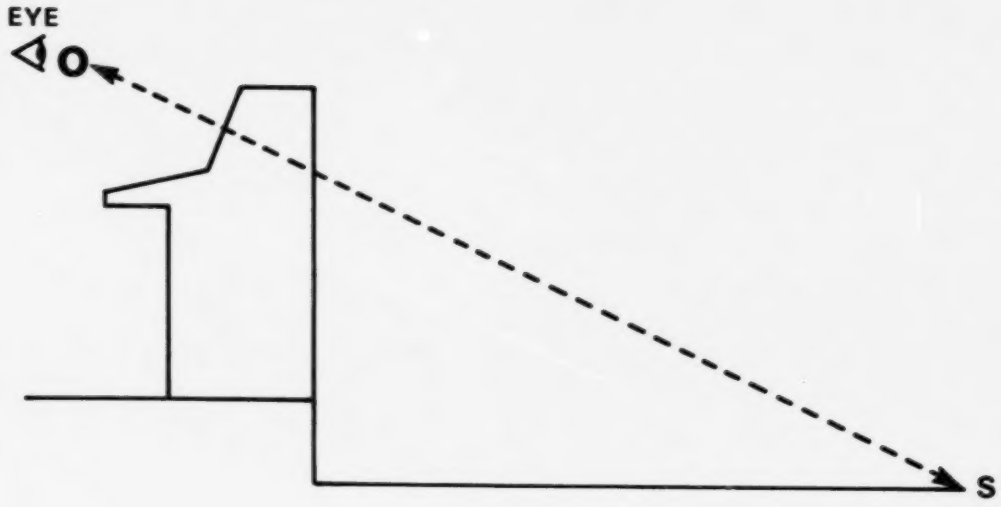


Figure 3/ Commercial Console Visibility

An observer of average height would have eyes located at "O" and a path from there to the scale edge "S" would pass right through this commercial console.

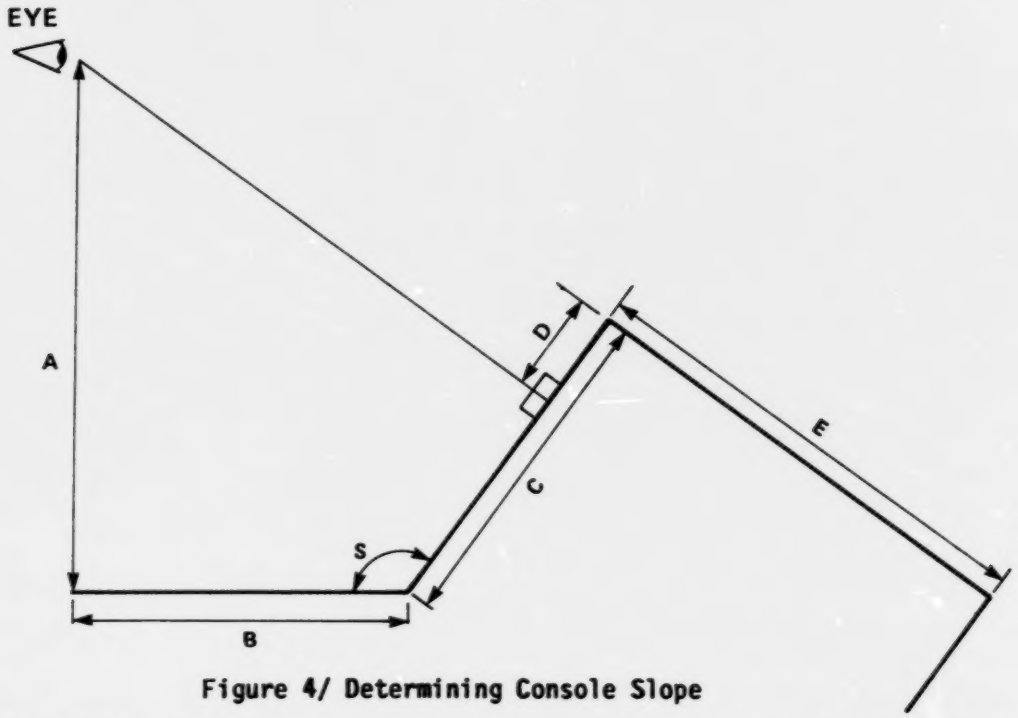


Figure 4/ Determining Console Slope

For a fifth percentile male or average female, the distance "A" from the eye to a work surface is 403.86 mm (15.9 inches). "B" is a 254 mm (10 inch) work surface attached to a 254 mm high, "C", display. In order to make the prime display area perpendicular to the line-of-sight, the angle "S" must be about 125°. "E" represents a depth of about 355 mm (14 inches).

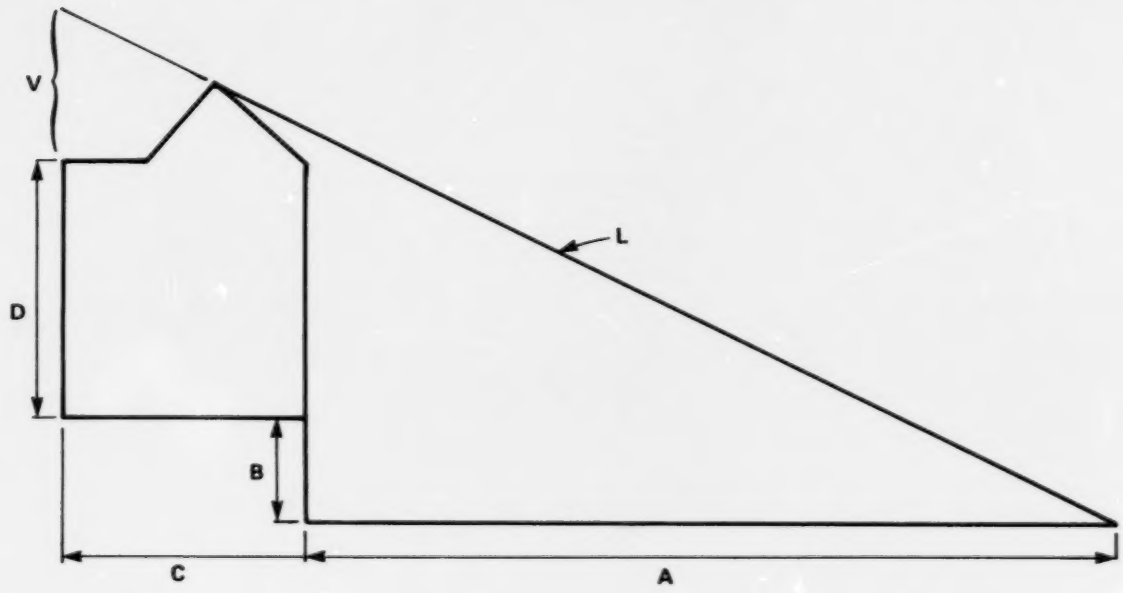


Figure 5/ Confirmation of Visibility

Determination of who can see over the proposed design. This shows that only the very shortest adults will have any difficulty seeing both the scale and the console (see text for details).

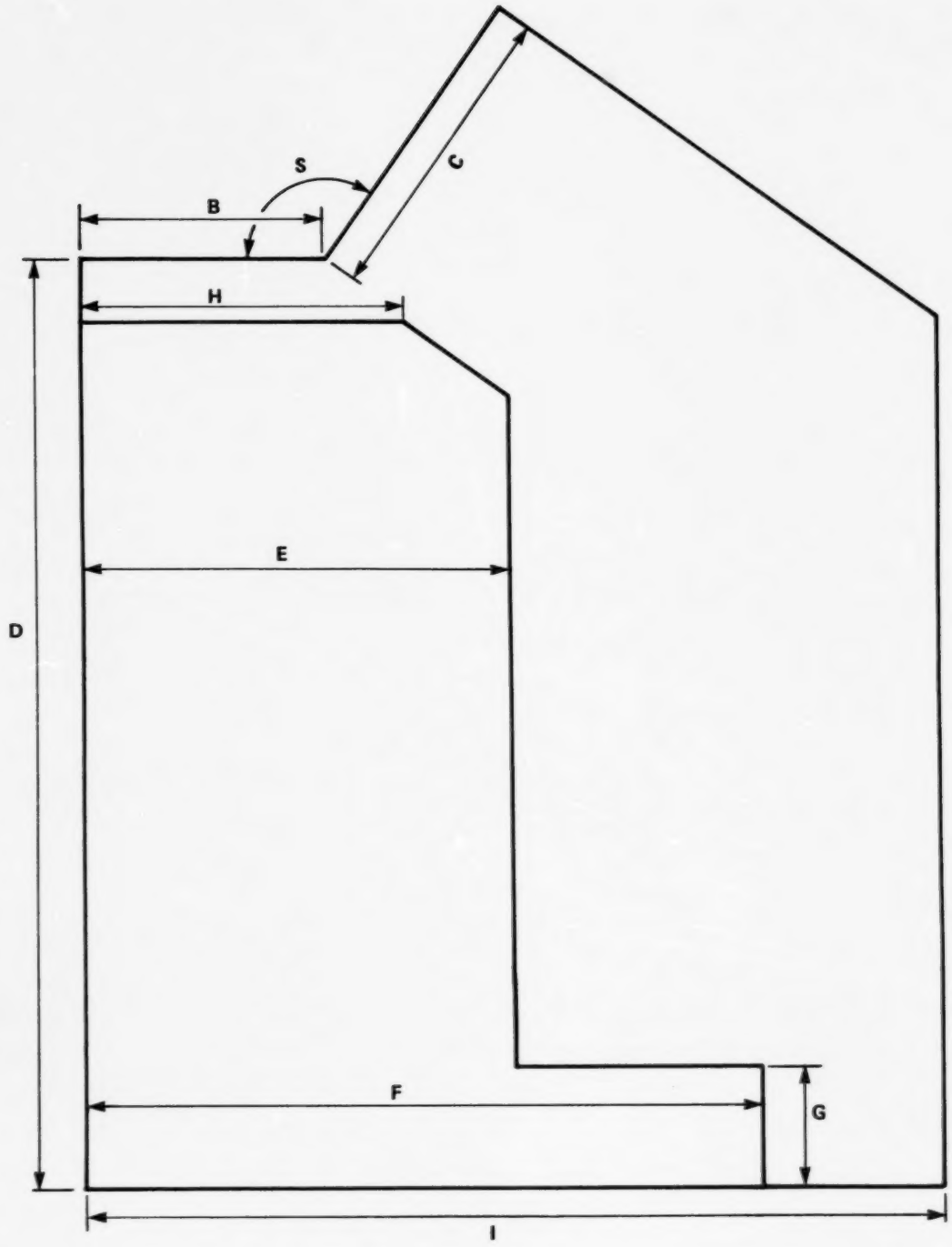


Figure 6/ Console Cross-Section

The console cross-section, see Table 2 for numerical values.

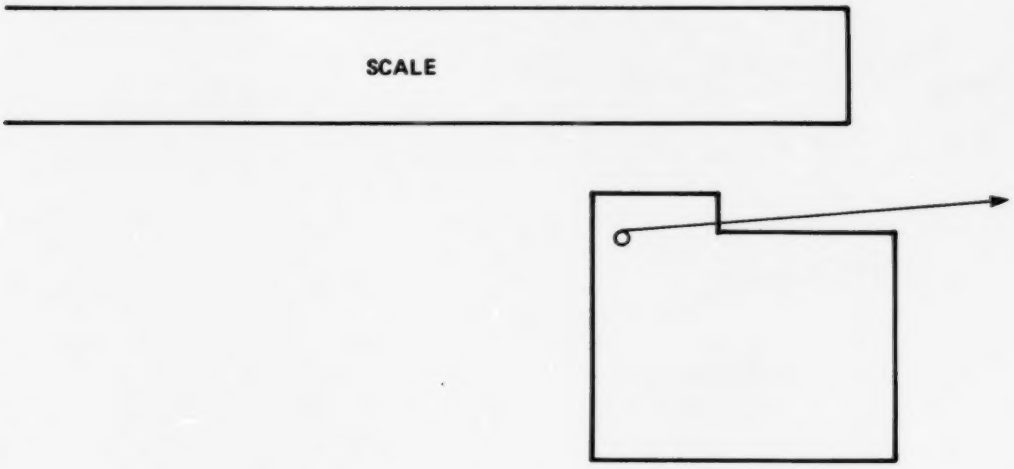


Figure 7/ Horizontal Visibility

The arrow shows the line-of-sight of an average adult seated at the proposed console and shows that there is excellent visibility to the right.

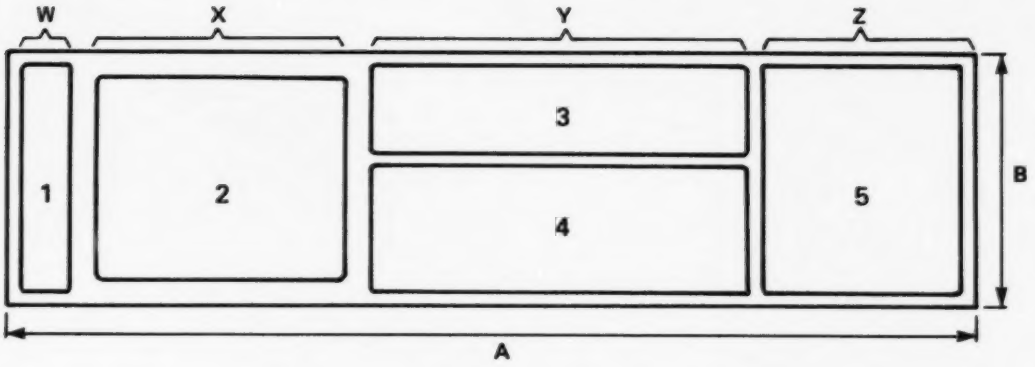


Figure 8/ Layout of Panel

The overall control panel layout showing the relative size and spacing of the five subpanels.

A = 978 mm (38.5 inches)
B = 254 mm (10.0 inches)

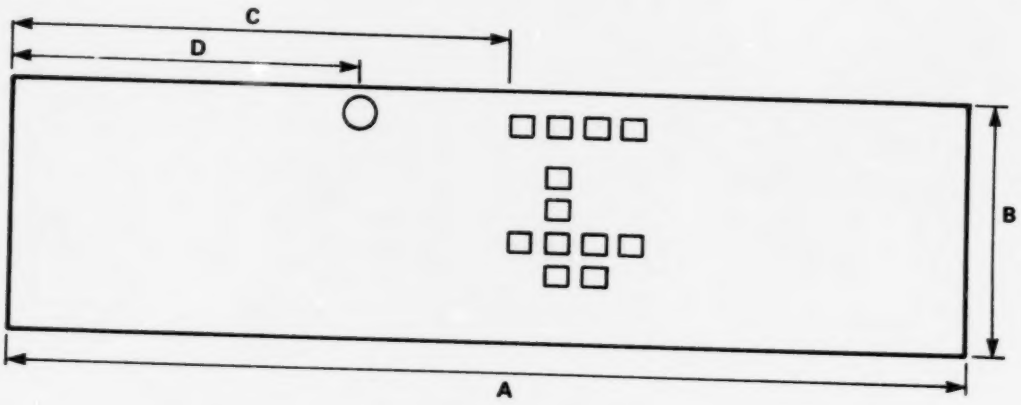


Figure 9/ Layout of Work Surface

The overall control panel layout showing the VMS keypad and the circular mount for the microphone.

A = 978 mm (38.5 inches)
B = 254 mm (10.0 inches)

```
<VEHICLE 1550                                          AXLES LENGTH WEIGHT
 WEIGHTS                                                  8      57   44.2
 TAN WTS          8.8          9.1          9.8                8.0          8.5
 SPACING                   \18.9/       \17.8/
                    10.6       3.1          3.1          25.0
      ==========================================
<VEHICLE 1551                                          AXLES LENGTH WEIGHT ==
 WEIGHTS                                                  8      57   45.2
 TAN WTS          8.8          9.1          9.8                8.0          9.5
 SPACING                   \18.9/       \17.8/
                    10.6       3.1          3.1          25.0
      ================================================================

<VEHICLE ENTERED FROM PARKING AREA

<VEHICLE 1552 MISSED SCALE

<VEHICLE 1553                                          AXLES LENGTH WEIGHT
 WEIGHTS                                                  8      57  117.2
 TAN WTS          8.8        50.1          40.8               8.0          9.5
 SPACING                   \90.9/       \48.8/
                    10.6       3.1          3.1          25.0
```

Figure 10/ Presorter Output

Sample presorter display with an alarm message and an overweight warning.

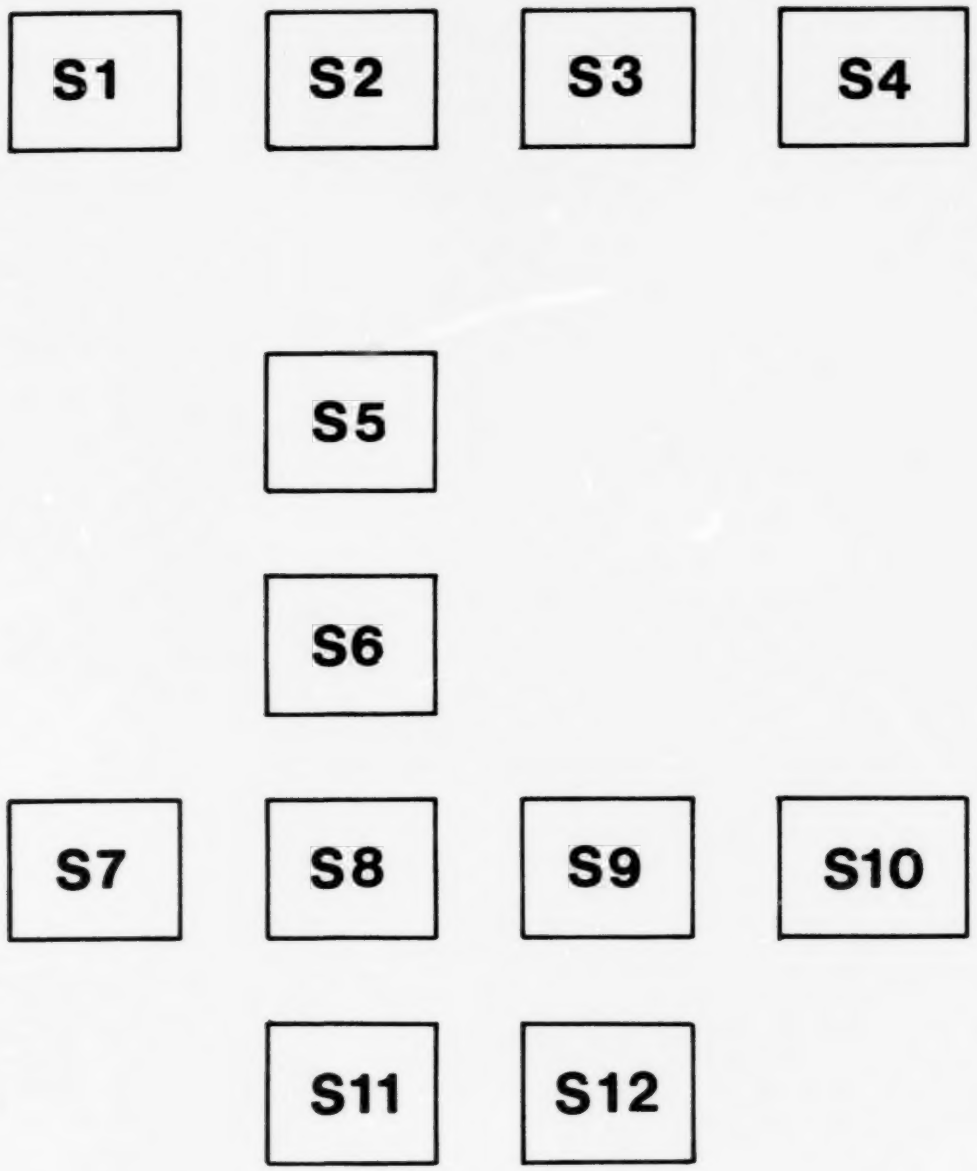


Figure 11/ VMS Keypad

This shows the VMS keypad in full scale.

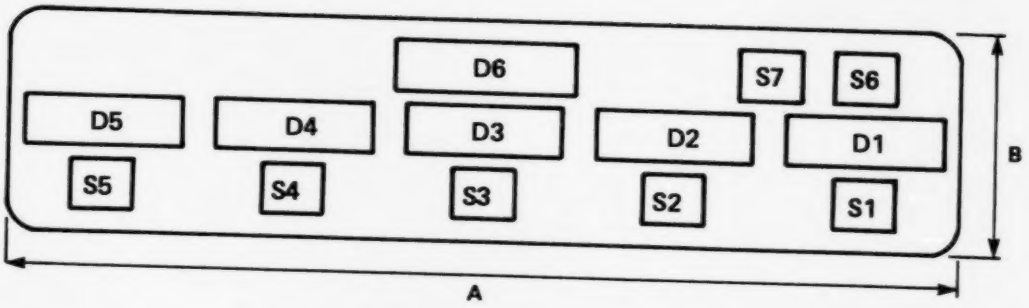


Figure 12/ The Five-Platform Scale Subpanel

The five-platform scale subpanel and the relative size and spacing of its displays and controls.

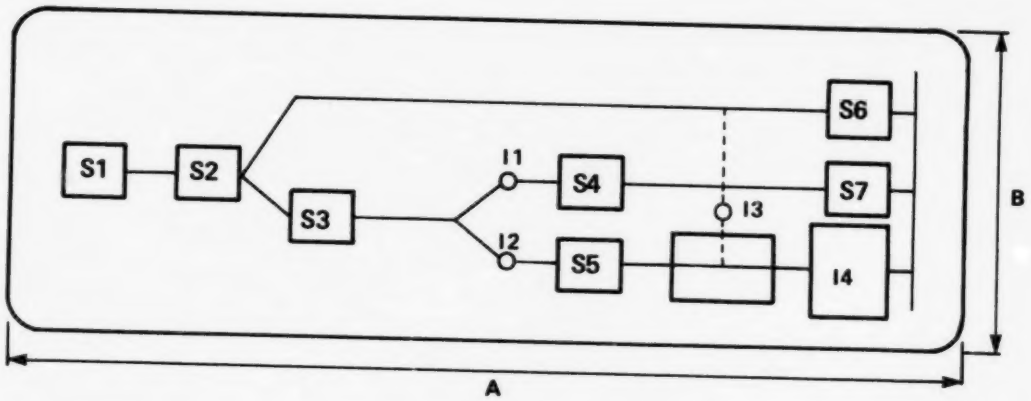


Figure 13/ The Traffic Control Subpanel

The overall layout of the traffic control subpanel showing switches, indicators, and engraving.

A = 381 mm (15 inches)
B = 127 mm (5 inches)

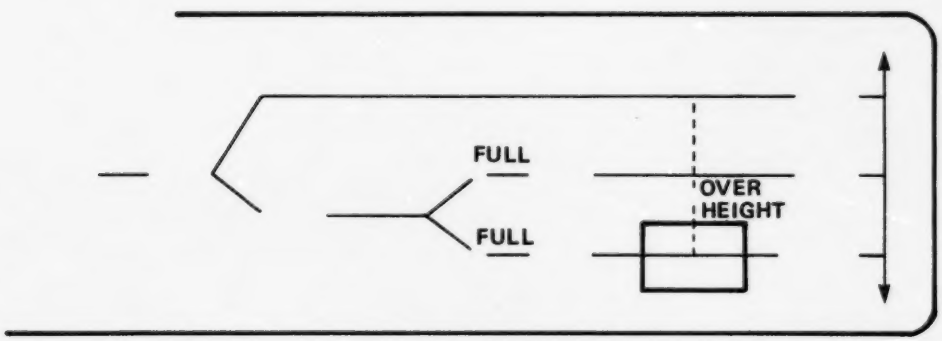


Figure 14/ The Traffic Control Engraving

This shows just the engraving for the traffic control subpanel so that it may be clearly distinguished. All lines representing the traffic lanes will be filled black. The box representing the scale will be filled blue and the line representing the over-height beam (dashed in this drawing) will be solid and filled red.

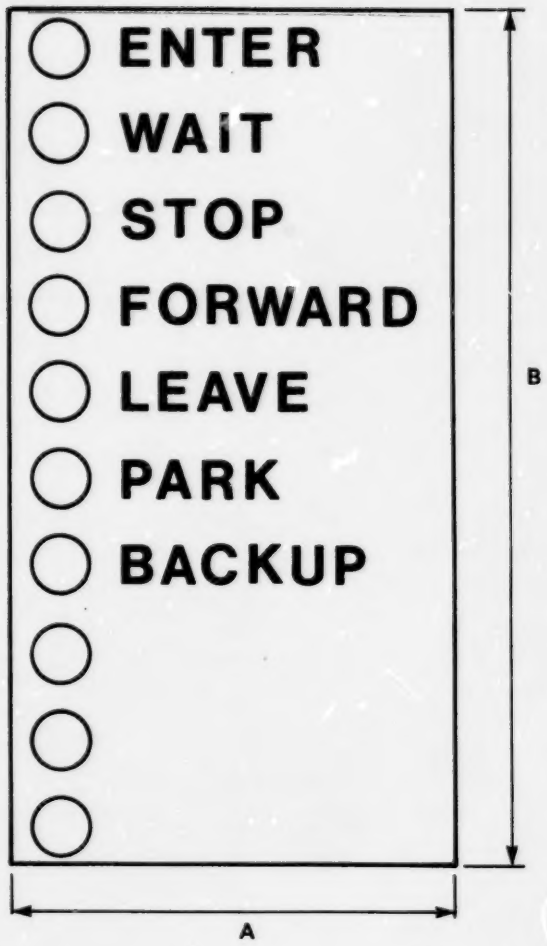
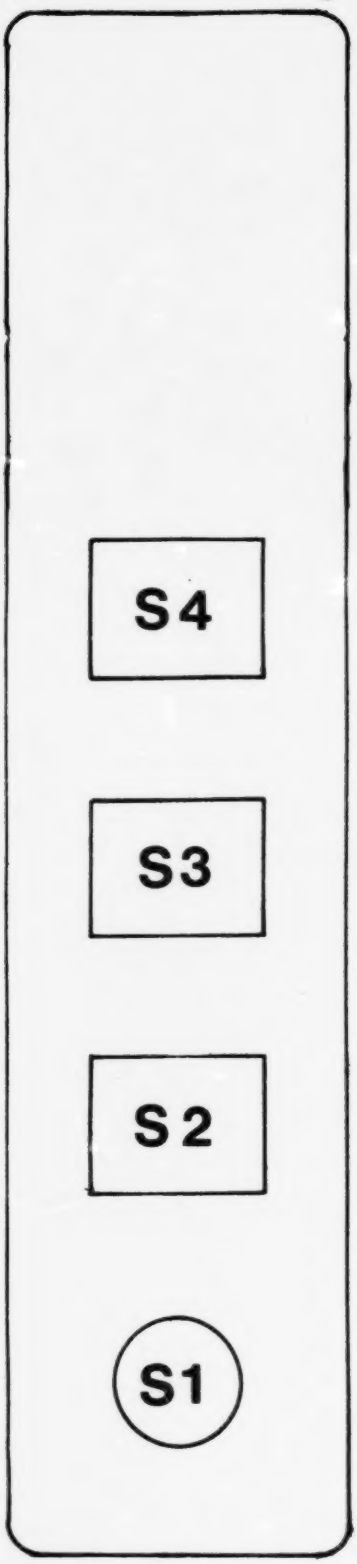


Figure 15/ VMS Display Panel

A small black subpanel with white engraved lettering showing which VMS message is being displayed. To the left of each engraved line is a yellow LED which lights to show which VMS message is displayed.

A = 33 mm (1.3 inches)
B = 44.5 mm (1.75 inches)



S4
TEST BUTTON

S3
EXTERNAL LIGHTING

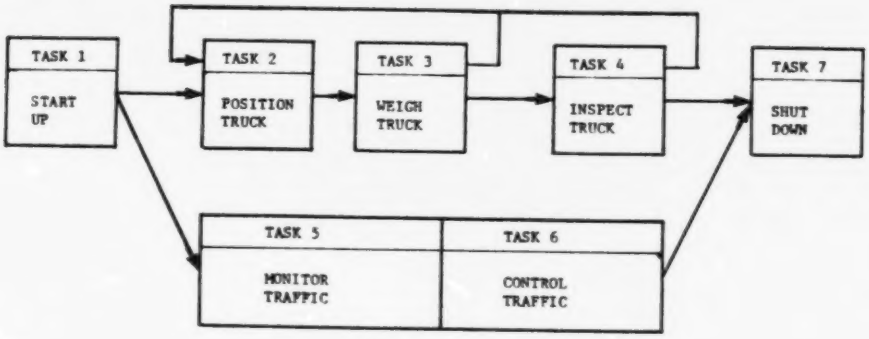
S2
MAIN POWER

S1
KEY

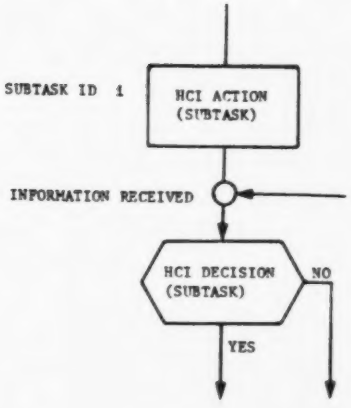
Figure 16/ Power Subpanel

APPENDIX A/ Operational Sequence Diagrams

OVERALL STRUCTURE OF HCI TASKS

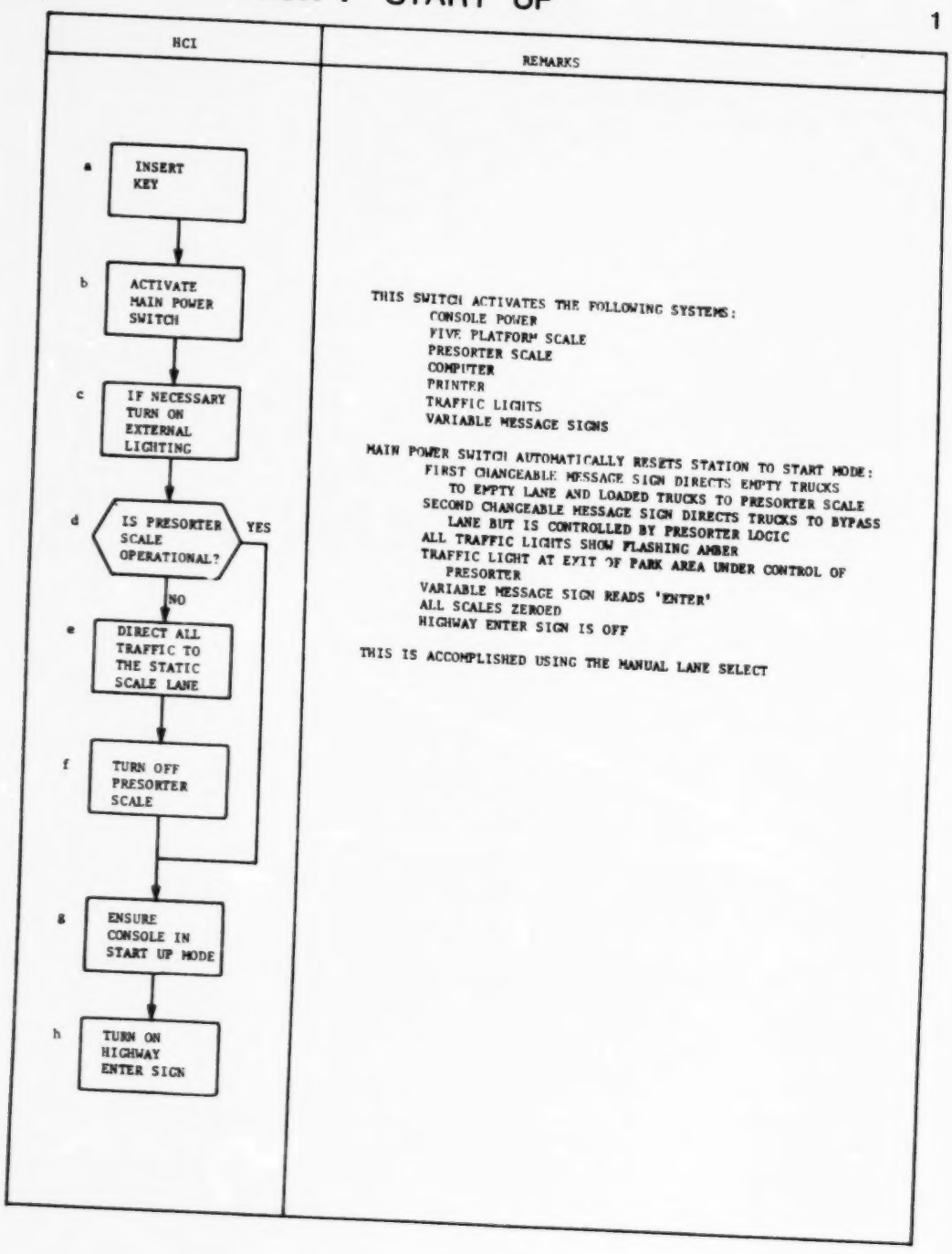


OSD LEGEND

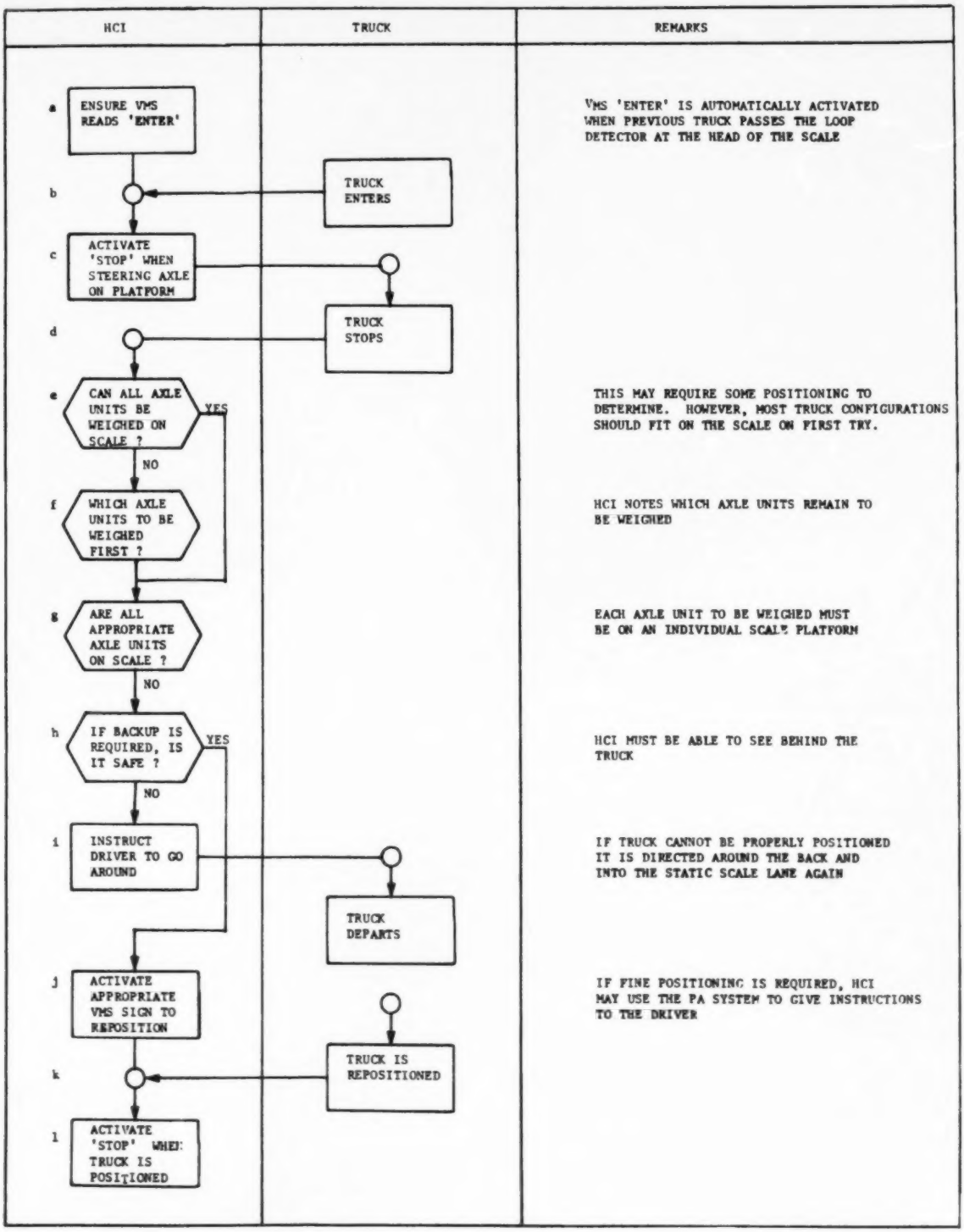


TASK 1 START UP

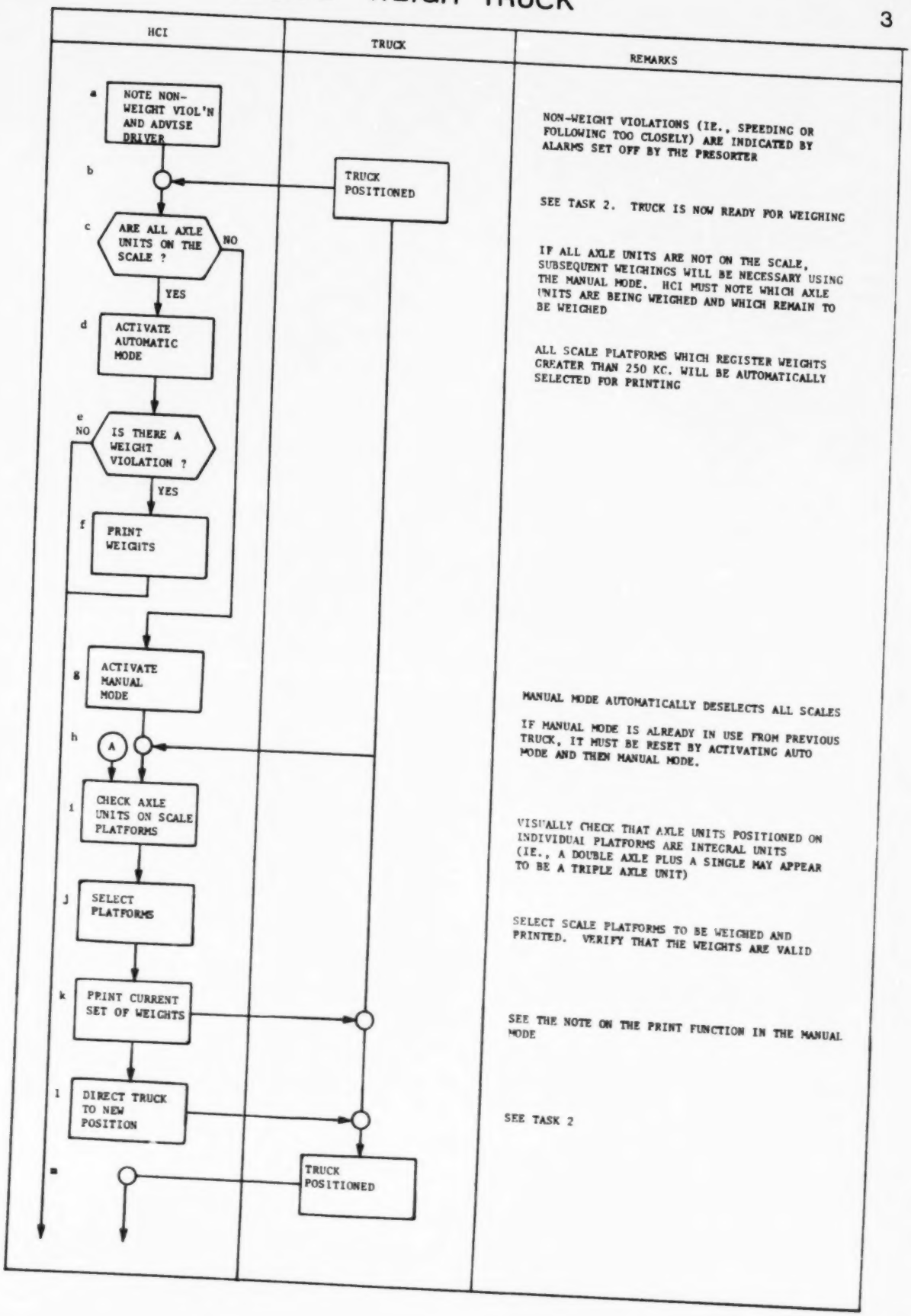
1


HCI
REMARKS
a
INSERT KEY
b
ACTIVATE MAIN POWER SWITCH
c
IF NECESSARY TURN ON EXTERNAL LIGHTING
d
IS PRESORTER SCALE OPERATIONAL?
YES
NO
e
DIRECT ALL TRAFFIC TO THE STATIC SCALE LANE
f
TURN OFF PRESORTER SCALE
g
ENSURE CONSOLE IN START UP MODE
h
TURN ON HIGHWAY ENTER SIGN
THIS SWITCH ACTIVATES THE FOLLOWING SYSTEMS:
CONSOLE POWER
FIVE PLATFORM SCALE
PRESORTER SCALE
COMPUTER
PRINTER
TRAFFIC LIGHTS
VARIABLE MESSAGE SIGNS
MAIN POWER SWITCH AUTOMATICALLY RESETS STATION TO START MODE:
FIRST CHANGEABLE MESSAGE SIGN DIRECTS EMPTY TRUCKS TO EMPTY LANE AND LOADED TRUCKS TO PRESORTER SCALE
SECOND CHANGEABLE MESSAGE SIGN DIRECTS TRUCKS TO BYPASS LANE BUT IS CONTROLLED BY PRESORTER LOGIC
ALL TRAFFIC LIGHTS SHOW FLASHING AMBER
TRAFFIC LIGHT AT EXIT OF PARK AREA UNDER CONTROL OF PRESORTER
VARIABLE MESSAGE SIGN READS 'ENTER'
ALL SCALES ZEROED
HIGHWAY ENTER SIGN IS OFF
THIS IS ACCOMPLISHED USING THE MANUAL LANE SELECT

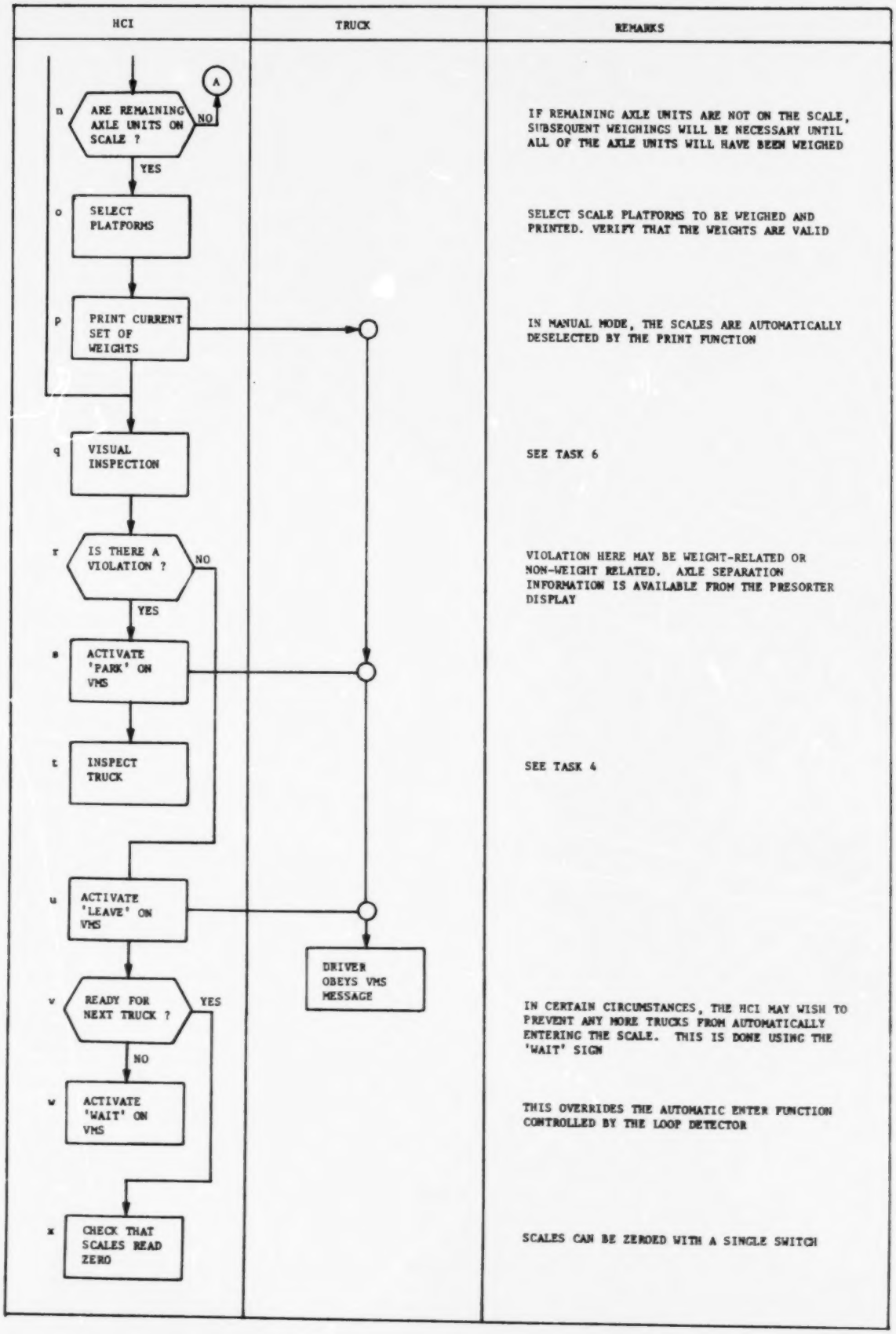
TASK 2 POSITION TRUCK


HCI
TRUCK
REMARKS
a
ENSURE VMS READS 'ENTER'
VMS 'ENTER' IS AUTOMATICALLY ACTIVATED WHEN PREVIOUS TRUCK PASSES THE LOOP DETECTOR AT THE HEAD OF THE SCALE
b
TRUCK ENTERS
c
ACTIVATE 'STOP' WHEN STEERING AXLE ON PLATFORM
d
TRUCK STOPS
e
CAN ALL AXLE UNITS BE WEIGHED ON SCALE ?
YES
NO
THIS MAY REQUIRE SOME POSITIONING TO DETERMINE. HOWEVER, MOST TRUCK CONFIGURATIONS SHOULD FIT ON THE SCALE ON FIRST TRY.
f
WHICH AXLE UNITS TO BE WEIGHED FIRST ?
HCI NOTES WHICH AXLE UNITS REMAIN TO BE WEIGHED
g
ARE ALL APPROPRIATE AXLE UNITS ON SCALE ?
NO
EACH AXLE UNIT TO BE WEIGHED MUST BE ON AN INDIVIDUAL SCALE PLATFORM
h
IF BACKUP IS REQUIRED, IS IT SAFE ?
YES
NO
HCI MUST BE ABLE TO SEE BEHIND THE TRUCK
i
INSTRUCT DRIVER TO GO AROUND
TRUCK DEPARTS
IF TRUCK CANNOT BE PROPERLY POSITIONED IT IS DIRECTED AROUND THE BACK AND INTO THE STATIC SCALE LANE AGAIN
j
ACTIVATE APPROPRIATE VMS SIGN TO REPOSITION
IF FINE POSITIONING IS REQUIRED, HCI MAY USE THE PA SYSTEM TO GIVE INSTRUCTIONS TO THE DRIVER
k
TRUCK IS REPOSITIONED
l
ACTIVATE 'STOP' WHEN TRUCK IS POSITIONED

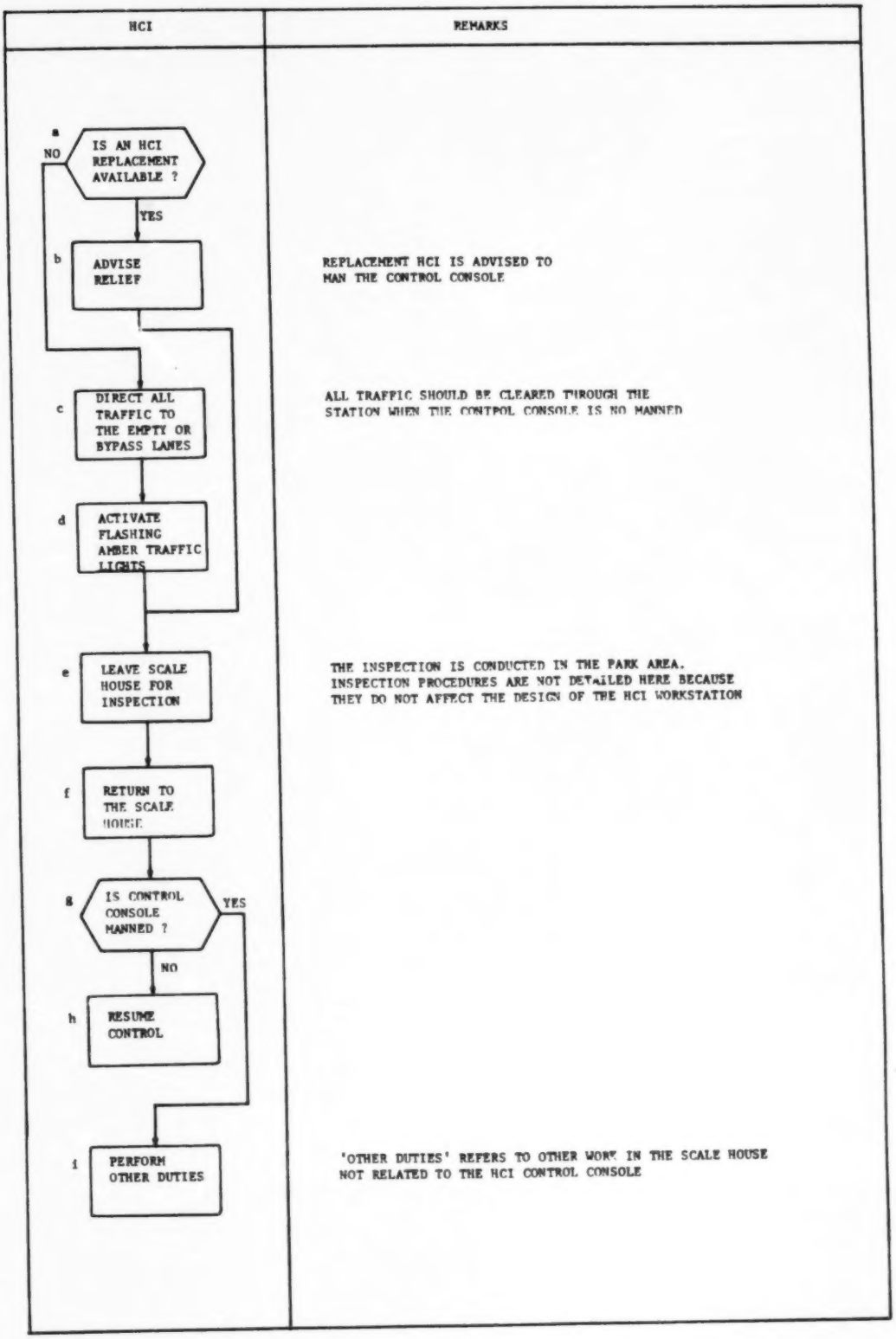
TASK 3 WEIGH TRUCK


HCI
TRUCK
REMARKS
a
NOTE NON-WEIGHT VIOL'N AND ADVISE DRIVER
NON-WEIGHT VIOLATIONS (IE., SPEEDING OR FOLLOWING TOO CLOSELY) ARE INDICATED BY ALARMS SET OFF BY THE PRESORTER
b
TRUCK POSITIONED
SEE TASK 2. TRUCK IS NOW READY FOR WEIGHING
c
ARE ALL AXLE UNITS ON THE SCALE ?
NO
YES
IF ALL AXLE UNITS ARE NOT ON THE SCALE, SUBSEQUENT WEIGHINGS WILL BE NECESSARY USING THE MANUAL MODE. HCI MUST NOTE WHICH AXLE UNITS ARE BEING WEIGHED AND WHICH REMAIN TO BE WEIGHED
d
ACTIVATE AUTOMATIC MODE
ALL SCALE PLATFORMS WHICH REGISTER WEIGHTS GREATER THAN 250 KG. WILL BE AUTOMATICALLY SELECTED FOR PRINTING
e
NO
IS THERE A WEIGHT VIOLATION ?
YES
f
PRINT WEIGHTS
g
ACTIVATE MANUAL MODE
MANUAL MODE AUTOMATICALLY DESELECTS ALL SCALES
h
A
IF MANUAL MODE IS ALREADY IN USE FROM PREVIOUS TRUCK, IT MUST BE RESET BY ACTIVATING AUTO MODE AND THEN MANUAL MODE.
i
CHECK AXLE UNITS ON SCALE PLATFORMS
VISUALLY CHECK THAT AXLE UNITS POSITIONED ON INDIVIDUAL PLATFORMS ARE INTEGRAL UNITS (IE., A DOUBLE AXLE PLUS A SINGLE MAY APPEAR TO BE A TRIPLE AXLE UNIT)
j
SELECT PLATFORMS
SELECT SCALE PLATFORMS TO BE WEIGHED AND PRINTED. VERIFY THAT THE WEIGHTS ARE VALID
k
PRINT CURRENT SET OF WEIGHTS
SEE THE NOTE ON THE PRINT FUNCTION IN THE MANUAL MODE
l
DIRECT TRUCK TO NEW POSITION
SEE TASK 2
m
TRUCK POSITIONED

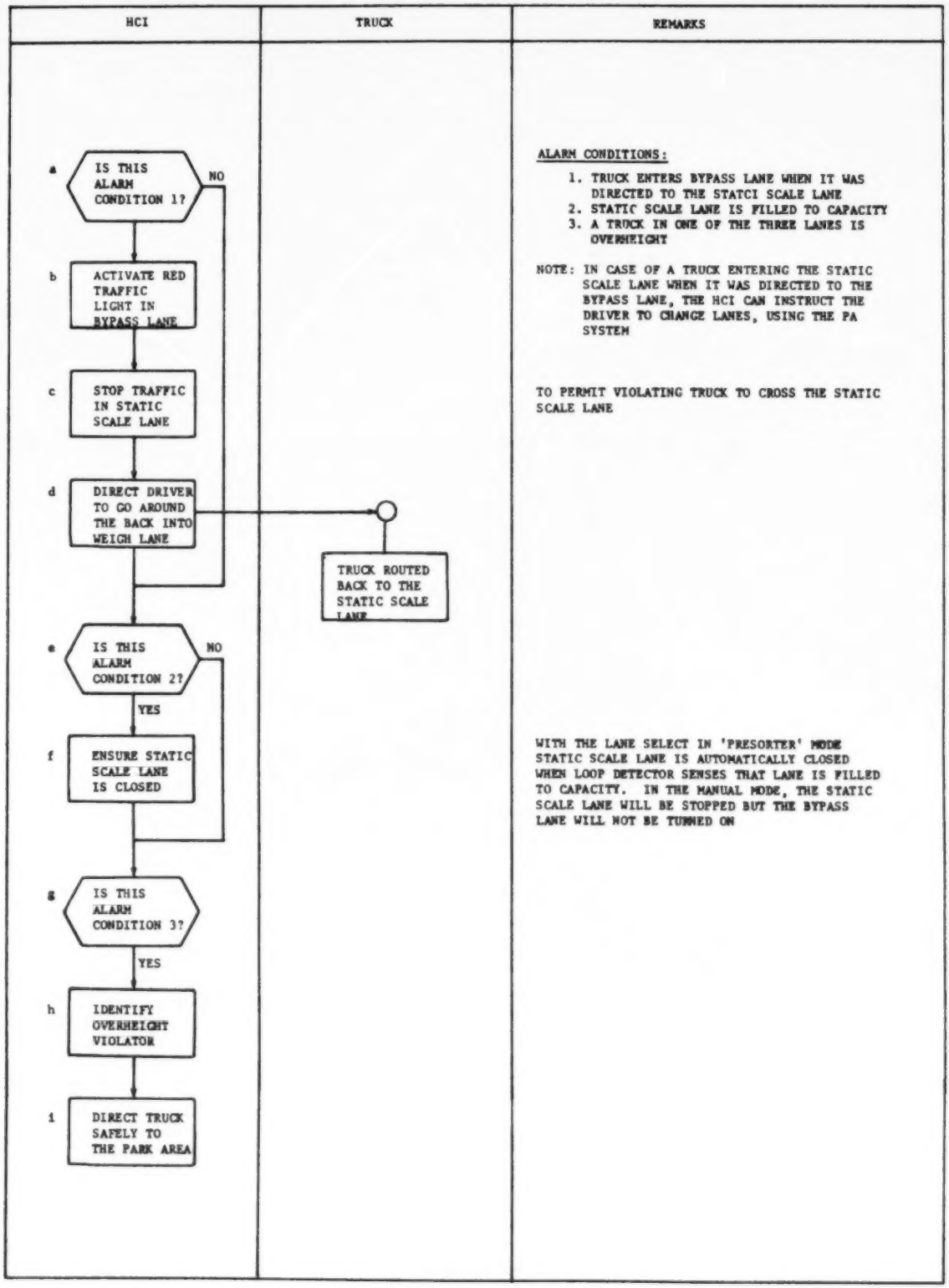
TASK 3 cont'd


HCI
TRUCK
REMARKS
A
n
ARE REMAINING AXLE UNITS ON SCALE ?
NO
YES
IF REMAINING AXLE UNITS ARE NOT ON THE SCALE, SUBSEQUENT WEIGHINGS WILL BE NECESSARY UNTIL ALL OF THE AXLE UNITS WILL HAVE BEEN WEIGHED
o
SELECT PLATFORMS
SELECT SCALE PLATFORMS TO BE WEIGHED AND PRINTED. VERIFY THAT THE WEIGHTS ARE VALID
p
PRINT CURRENT SET OF WEIGHTS
IN MANUAL MODE, THE SCALES ARE AUTOMATICALLY DESELECTED BY THE PRINT FUNCTION
q
VISUAL INSPECTION
SEE TASK 6
r
IS THERE A VIOLATION ?
NO
YES
VIOLATION HERE MAY BE WEIGHT-RELATED OR NON-WEIGHT RELATED. AXLE SEPARATION INFORMATION IS AVAILABLE FROM THE PRESORTER DISPLAY
s
ACTIVATE 'PARK' ON VMS
t
INSPECT TRUCK
SEE TASK 4
u
ACTIVATE 'LEAVE' ON VMS
DRIVER OBEYS VMS MESSAGE
v
READY FOR NEXT TRUCK ?
YES
NO
IN CERTAIN CIRCUMSTANCES, THE HCI MAY WISH TO PREVENT ANY MORE TRUCKS FROM AUTOMATICALLY ENTERING THE SCALE. THIS IS DONE USING THE 'WAIT' SIGN
w
ACTIVATE 'WAIT' ON VMS
THIS OVERRIDES THE AUTOMATIC ENTER FUNCTION CONTROLLED BY THE LOOP DETECTOR
x
CHECK THAT SCALES READ ZERO
SCALES CAN BE ZEROED WITH A SINGLE SWITCH

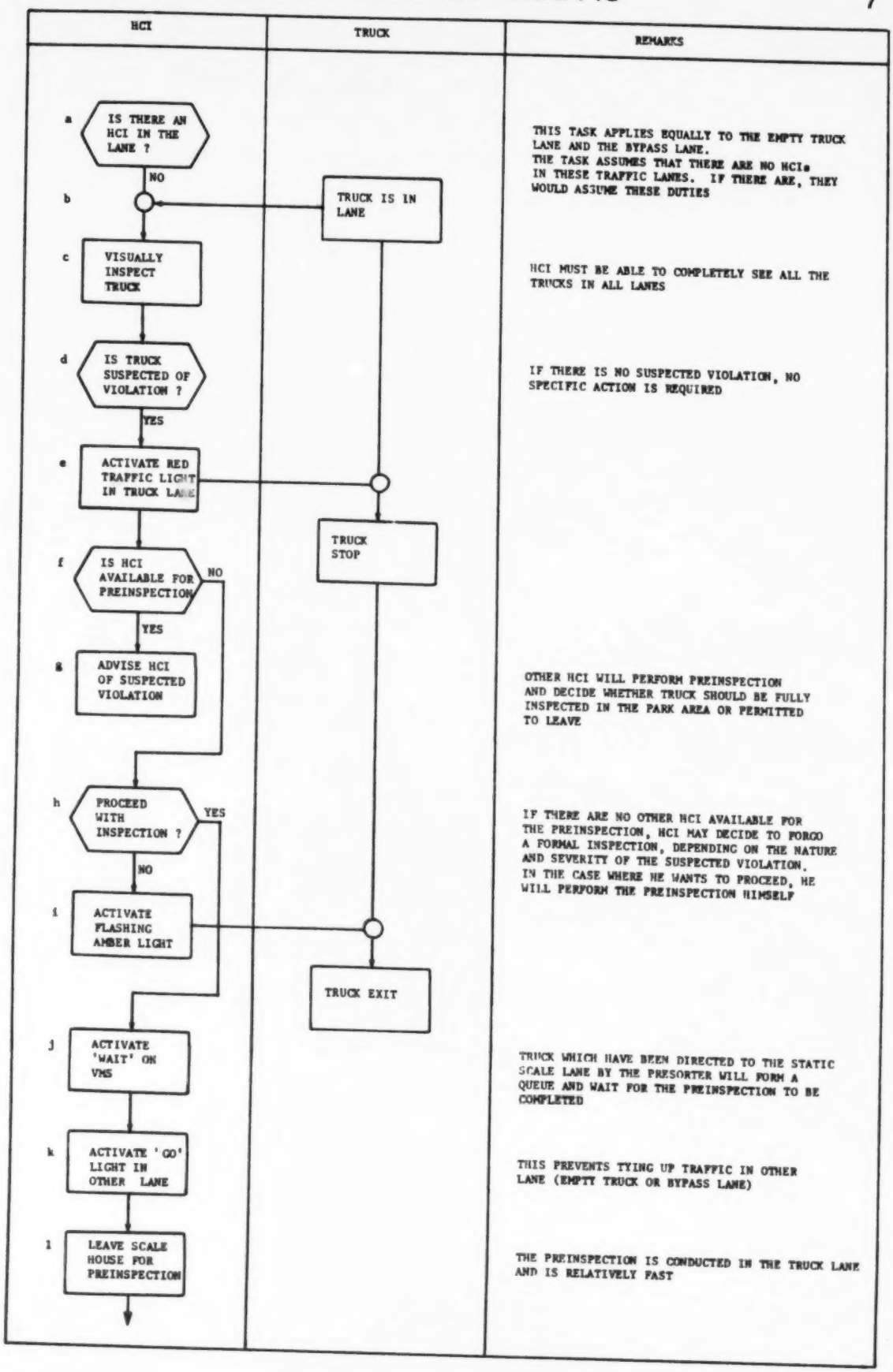
TASK 4 INSPECT TRUCK 5


HCI
REMARKS
a
IS AN HCI REPLACEMENT AVAILABLE ?
NO
YES
b
ADVISE RELIEF
REPLACEMENT HCI IS ADVISED TO MAN THE CONTROL CONSOLE
c
DIRECT ALL TRAFFIC TO THE EMPTY OR BYPASS LANES
ALL TRAFFIC SHOULD BE CLEARED THROUGH THE STATION WHEN THE CONTROL CONSOLE IS NO MANNED
d
ACTIVATE FLASHING AMBER TRAFFIC LIGHTS
e
LEAVE SCALE HOUSE FOR INSPECTION
THE INSPECTION IS CONDUCTED IN THE PARK AREA. INSPECTION PROCEDURES ARE NOT DETAILED HERE BECAUSE THEY DO NOT AFFECT THE DESIGN OF THE HCI WORKSTATION
f
RETURN TO THE SCALE HOUSE
g
IS CONTROL CONSOLE MANNED ?
YES
NO
h
RESUME CONTROL
i
PERFORM OTHER DUTIES
'OTHER DUTIES' REFERS TO OTHER WORK IN THE SCALE HOUSE NOT RELATED TO THE HCI CONTROL CONSOLE

TASK 5 MONITOR TRAFFIC

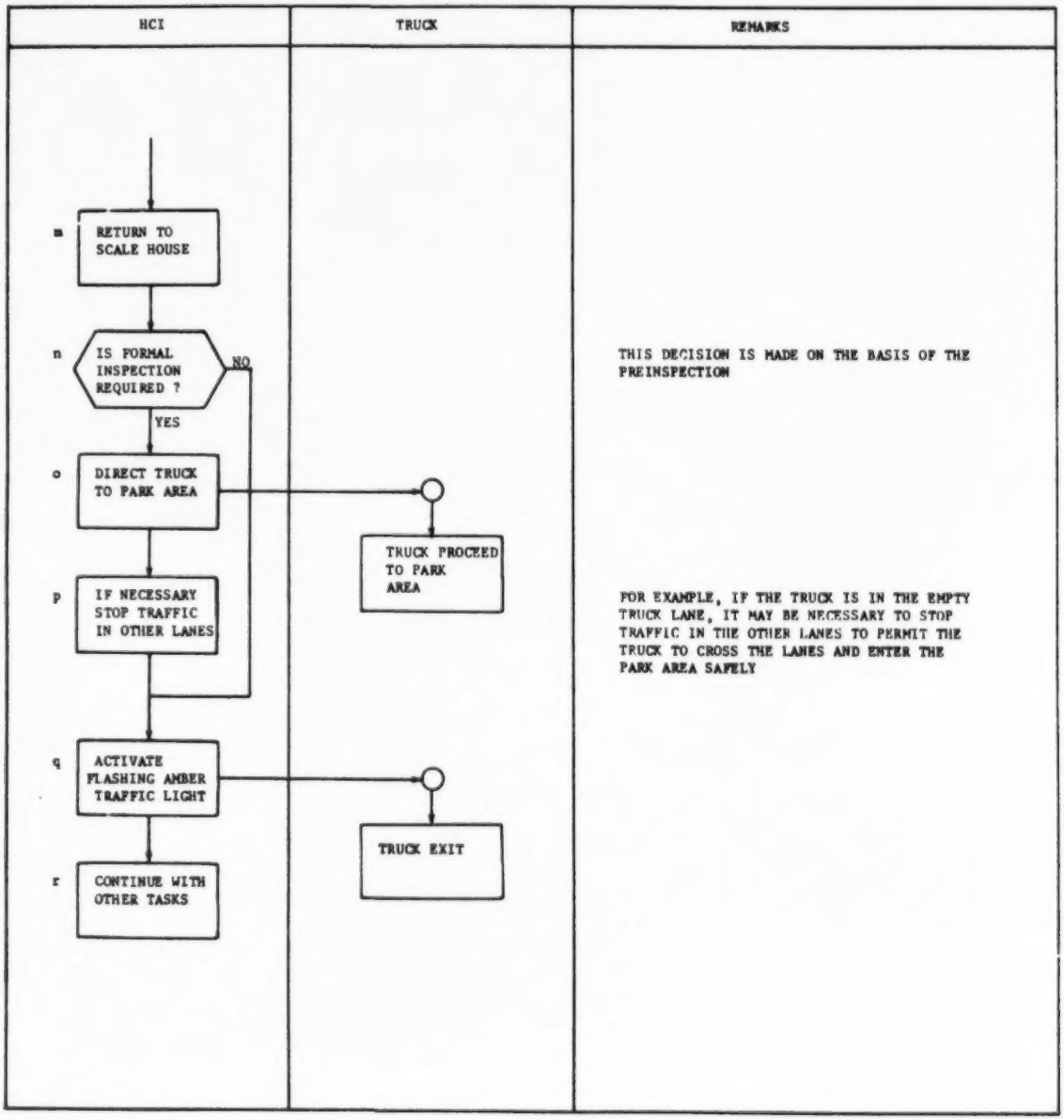

HCI
TRUCK
REMARKS
a
IS THIS ALARM CONDITION 1?
NO
b
ACTIVATE RED TRAFFIC LIGHT IN BYPASS LANE
c
STOP TRAFFIC IN STATIC SCALE LANE
d
DIRECT DRIVER TO GO AROUND THE BACK INTO WEIGH LANE
TRUCK ROUTED BACK TO THE STATIC SCALE LANE
e
IS THIS ALARM CONDITION 2?
NO
YES
f
ENSURE STATIC SCALE LANE IS CLOSED
g
IS THIS ALARM CONDITION 3?
YES
h
IDENTIFY OVERHEIGHT VIOLATOR
i
DIRECT TRUCK SAFELY TO THE PARK AREA
ALARM CONDITIONS:
1. TRUCK ENTERS BYPASS LANE WHEN IT WAS DIRECTED TO THE STATCI SCALE LANE
2. STATIC SCALE LANE IS FILLED TO CAPACITY
3. A TRUCK IN ONE OF THE THREE LANES IS OVERHEIGHT
NOTE: IN CASE OF A TRUCK ENTERING THE STATIC SCALE LANE WHEN IT WAS DIRECTED TO THE BYPASS LANE, THE HCI CAN INSTRUCT THE DRIVER TO CHANGE LANES, USING THE PA SYSTEM
TO PERMIT VIOLATING TRUCK TO CROSS THE STATIC SCALE LANE
WITH THE LANE SELECT IN 'PRESORTER' MODE STATIC SCALE LANE IS AUTOMATICALLY CLOSED WHEN LOOP DETECTOR SENSES THAT LANE IS FILLED TO CAPACITY. IN THE MANUAL MODE, THE STATIC SCALE LANE WILL BE STOPPED BUT THE BYPASS LANE WILL NOT BE TURNED ON

TASK 6 CONTROL TRAFFIC


HCI
TRUCK
REMARKS
a
IS THERE AN HCI IN THE LANE ?
NO
b
TRUCK IS IN LANE
c
VISUALLY INSPECT TRUCK
d
IS TRUCK SUSPECTED OF VIOLATION ?
YES
e
ACTIVATE RED TRAFFIC LIGHT IN TRUCK LANE
TRUCK STOP
f
IS HCI AVAILABLE FOR PREINSPECTION
NO
YES
g
ADVISE HCI OF SUSPECTED VIOLATION
h
PROCEED WITH INSPECTION ?
YES
NO
i
ACTIVATE FLASHING AMBER LIGHT
TRUCK EXIT
j
ACTIVATE 'WAIT' ON VMS
k
ACTIVATE 'GO' LIGHT IN OTHER LANE
l
LEAVE SCALE HOUSE FOR PREINSPECTION
THIS TASK APPLIES EQUALLY TO THE EMPTY TRUCK LANE AND THE BYPASS LANE. THE TASK ASSUMES THAT THERE ARE NO HCIs IN THESE TRAFFIC LANES. IF THERE ARE, THEY WOULD ASSUME THESE DUTIES
HCI MUST BE ABLE TO COMPLETELY SEE ALL THE TRUCKS IN ALL LANES
IF THERE IS NO SUSPECTED VIOLATION, NO SPECIFIC ACTION IS REQUIRED
OTHER HCI WILL PERFORM PREINSPECTION AND DECIDE WHETHER TRUCK SHOULD BE FULLY INSPECTED IN THE PARK AREA OR PERMITTED TO LEAVE
IF THERE ARE NO OTHER HCI AVAILABLE FOR THE PREINSPECTION, HCI MAY DECIDE TO FORGO A FORMAL INSPECTION, DEPENDING ON THE NATURE AND SEVERITY OF THE SUSPECTED VIOLATION. IN THE CASE WHERE HE WANTS TO PROCEED, HE WILL PERFORM THE PREINSPECTION HIMSELF
TRUCK WHICH HAVE BEEN DIRECTED TO THE STATIC SCALE LANE BY THE PRESORTER WILL FORM A QUEUE AND WAIT FOR THE PREINSPECTION TO BE COMPLETED
THIS PREVENTS TYING UP TRAFFIC IN OTHER LANE (EMPTY TRUCK OR BYPASS LANE)
THE PREINSPECTION IS CONDUCTED IN THE TRUCK LANE AND IS RELATIVELY FAST

TASK 6 cont'd

8


HCI
TRUCK
REMARKS
m
RETURN TO SCALE HOUSE
n
IS FORMAL INSPECTION REQUIRED ?
NO
YES
THIS DECISION IS MADE ON THE BASIS OF THE PREINSPECTION
o
DIRECT TRUCK TO PARK AREA
TRUCK PROCEED TO PARK AREA
p
IF NECESSARY STOP TRAFFIC IN OTHER LANES
FOR EXAMPLE, IF THE TRUCK IS IN THE EMPTY TRUCK LANE, IT MAY BE NECESSARY TO STOP TRAFFIC IN THE OTHER LANES TO PERMIT THE TRUCK TO CROSS THE LANES AND ENTER THE PARK AREA SAFELY
q
ACTIVATE FLASHING AMBER TRAFFIC LIGHT
TRUCK EXIT
r
CONTINUE WITH OTHER TASKS

TASK 7 SHUT DOWN

9

HCI	REMARKS
a TURN OFF MAIN POWER ↓ b REMOVE KEY	

APPENDIX B/ Glossary

CMS: -changeable message sign (there are two of these).

First CMS: -used to direct empty and loaded trucks to the presorter or lane #3.

Second CMS: -used to direct loaded trucks into the lane #2 or lane #1.

VMS: -variable message sign.

Park area: -the area behind the scale house, used primarily for inspecting trucks.

Panel: -refers to the vertically sloped part of the console.

Subpanel: -refers a functionally separate component panel.

Lane #1: -the lane nearest the scale house containing the five-platform scale.

Lane #2: -the central lane.

Lane #3: -the lane furthest from the scale house.

Keypad: -the arrangement of keys on the flat horizontal portion of the console

Key: -refers to the the key for the locked switch or one of the keys on the keypad.

Console: -The overall workstation is called "the console".

HCI: -Highway Carrier Inspector.

TIS: -Truck Inspection Station.

VI. -Vehicle Inspector.

Switch: -refers to a switch on the "panel".